BLOOD-PRESSURE PRIMER

THE SPHYGMOMANOMETER AND ITS PRACTICAL APPLICATION

By F. A. FAUGHT

FIFTH EDITION

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BY

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Containing One Full-page Plate and Numerous Explanatory Diagrams in the Text

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Pilling-Faught Pocket Sphygmomanometer in Use.

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THE VALUE OF THE SPHYGMOMANOMETER.

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THE VALUE OF THE SPHYGMOMANOMETER AND THE IMPORTANCE OF THE BLOOD-PRESSURE TEST.

"The value of the blood-pressure test is acknowledged by every up-to-date physician. Like the clinical thermometer, the stethoscope and other instruments of precision, the sphygmomanometer is an aid to accuracy in diagnosis, and any instrument that will enable the physician or surgeon to do better work is not to be set aside or passed by without careful investigation." (J. F. Prendergast, Chicago Medical Record, March, 1913.)

The best single guide to the practical value of a new method is to determine whether it is receiving increasing endorsement from qualified authorities. At the present time all well-equipped hospitals have sphygmomanometers in daily use in the wards. It is seen in Children's Wards as a guide to prognosis and treatment; in Obstetrical Wards in diagnosis and treatment of toxemias.

The oculist and aurist are finding blood-pressure measurement of increasing value, and tuberculosis sanatoria are modifying their prognosis and treatment according to the indications of this sign.

J. B. McAllister, in "The Medical Council" for July, 1912, states that the Medical Director of a

large insurance company published statistics which show that in 1247 risks of all ages in which there was a blood-pressure of 150 mm. Hg. or over, the mortality was 2½ times greater than the general average mortality of the company covering the same period.

Richard C. Cabot says: "If I were allowed to have only two instruments of precision for my aid in physical diagnosis, they would be the stethoscope and sphygmomanometer. I have been saved from wrong diagnosis and put on the track of right ones more often by this machine than anything else I know of except the stethoscope. I regard this measurement of the blood-pressure as the most important of all the resources that have been added to our armamentarium as physicians in the last 15 years. I could talk all afternoon on the subject of blood-pressure, but I will confine myself to saying that it puts me right most often in relation to cardiac and renal diseases. Patients, the examination of whose hearts did not show anything certainly characteristic of disease, have often been shown to me to be diseased, or proved later to be diseased, by the high blood-pressure registered by the machine, pressure which my fingers are not always able to detect. In feeling the pulse I no longer trust my fingers to be sure of a high tension pulse; I used to, but I have convinced myself that I cannot do it. On the other side there are many irregular hearts, which you finally conclude to be merely functional in origin, having no immediate significance; because the blood-pressure is normal. An irregular heart plus a high blood-pressure is serious.

The very same irregular heart, with low pressure, may be of no great significance.

"Then call your attention to the early diagnosis of kidney lesions. I see a good many cases of renal disease entirely free from albumin or from casts, but with high blood-pressure, which are shown, post-mortem, to be renal disease. These cases could not have been suspected to be renal diseases except by blood-pressure. In other words, I regard the blood-pressure measurement as of more importance than the examination of the urine in chronic kidney trouble. Examination of a specimen has again and again led me astray; the measurement of blood-pressure almost never."

Physicians who can practice successfully without materials for a urinalysis or without a blood-pressure instrument will find it difficult to hold insurance appointments; furthermore, patients are learning that an examiner who is preferred by an old insurance company is the safest man to trust as a physician.

A hundred examiners could give us a reliable blood-pressure reading where only one could detect cardiac hypertrophy or an accentuated aortic second or a minute trace of albumin in chronic interstitial nephritis.

The foregoing has all been said of the simple estimation of the systolic blood-pressure, as made by the modern sphygmomanometer, of which the Faught instruments are typical. It must not be forgotten, however, that recent developments in the study of blood-pressure have emphasized the growing importance of the diastolic pressure. In this

connection I quote again from the article of Dr. Prendergast above referred to, in which he says: "Some of our clinicians place little value on diastolic pressure for the simple reason that they cannot interpret its findings. This is a great mistake, as the systolic pressure is only one side of the picture, and we cannot explain the pulse pressure or judge of the systolic output or the work the heart is doing without knowing the diastolic pressure. Now I contend that it is of great importance to know whether under certain conditions the pulse pressure, if 20, 40, 60 or even 100. In the first case it would mean a rather feeble drive to the heart, with a small systolic output. In the latter the heart is working too hard in overcoming peripheral resistance, or loss of elasticity in the vessel wall, and is calling on its reserve capacity; as long as it is compensated we have a good case, but once our reserve capacity is overcome and decompensation sets in, look out for trouble. The narrow pulse pressure is found in wasting diseases, like tuberculosis, in shock, after profuse hemorrhage, in chlorosis, etc., and always accompanies a failing heart."

DIASTOLIC TEST.

Until the practical demonstration of the accuracy of the *Auscultatory* or *Auditory* method of reading blood-pressure, little valuable work was recorded in connection with this test, for the reason that so much difficulty was experienced in making this part of the test, that few routinely employed it, and those who made this effort were not repaid for their trouble, as the figures obtained were so

uncertain and unreliable that no dependence could be placed on them.

The studies of Warfield and others have shown the accuracy of this method, which can be relied upon to give an accurate reading under practically all circumstances, irrespective of the age of the patient, the size of the vessel, or the size of the arm to which the cuff is attached.

In order to analyze the results of a complete blood-pressure observation, it is essential to review the factors controlling blood-pressure. From the clinical standpoint at least, we may consider the blood-pressure depending mainly upon the contractile powers of the heart, which pumps the blood forward, on the one hand, and the calibre of the blood-vessel walls, which offer peripheral resistance to its flow, on the other. And also that peripheral resistance itself depends largely on the tonicity of the walls of the blood-vessels which comprise the general capillary system. Pathologically, we must recognize that changes in blood-pressure are largely due to departures from the normal force of the heart and to alterations in the elasticity and tonicity of the general arterial tree. It will thus be seen that the systolic pressure will approximate closely the actual pressure developed by the heart within the heart itself at the moment of systole, while the minimal or diastolic pressure will be the measurement of the peripheral resistance, which is able to maintain to a varying degree the arterial pressure, while the heart is dilating, plus the factor of elasticity, which also aids in maintaining the continued pressure in the vessel during diastole.

In the pulse pressure, then, we must have the

measurement of the amount of force exerted by the heart in maintaining blood-pressure over and above that normally maintained by peripheral resistance, i. e., *the pulse-pressure gives a figure which roughly measures the pumping capacity of the heart.* These facts show clearly the importance of always making a diastolic reading, so that the pulse pressure may be computed.

Gibson, due to his ingenuity and experience, has devised formulae whereby we are able to more or less carefully estimate not only the capacity of the heart for work, but also, in a rough way, its output.

Gibson has demonstrated that there exist certain definite relations between these several factors and has combined them into a working formula. Briefly, these propositions are as follows:

Under normal conditions there is a definite relationship between systolic and diastolic pressure and also a relation between systolic and pulse-pressure. The relation of the diastolic pressure to the systolic pressure obtained by auscultation is about as two is to three and that of pulse-pressure to the systolic pressure as one is to three. For example, if the systolic pressure is 140, the normal diastolic will be approximately 95, while the pulse-pressure should approximate 45 or 50.

If we bear in mind the fundamental fact that all blood-pressure readings vary normally within certain well-known limits, it will readily be seen that these relations are at best only approximate, which, however, does not materially detract from their clinical value. Actually employed, they have been found to be most valuable guides in separating the normal from the pathological and in estimating the degree of over-load in cardio-renal cases.

Following the same reasoning, if the pulse-pressure roughly estimates the systolic output, it follows that this is also an important factor in the velocity of the blood-stream, which for physical reasons must bear a definite relation to the volume output of the heart and to the caliber of the conduits—the arteries—so that, if other factors remain the same, it is not a difficult matter to estimate both the velocity and also the work of the heart while operating under either normal or abnormal conditions.

The above propositions can, according to Gibson, be arranged graphically as follows:

For example, take a case presenting these figures: S. P. 130, D. P. 85, P. P. 45, P. R. 70; then—

P. P. (45) × P. R. (70) = Velocity (3100), and

S. P. (130) × P. R. (70) = Work (9100).

We may carry our calculations further and state that the velocity and the work, as estimated by the above formula, also bear a definite normal relation which is dependent entirely upon the normal relation of pulse-pressure to systolic pressure (which can only be determined by measuring the diastolic pressure).

This velocity-work relation is as one is to three, and is not dependent upon the pulse rate. For as long as the relation of systolic to diastolic pressures remain normal (they may of course be different in every case, without changing their normal relation), the velocity-work ratio will be normal, no matter what the pulse rate. If we have a more rapid pulse, with unchanged pressure, we undoubtedly increase the total expenditure of heart energy, both for velocity and work; on the other hand, it is possible to conceive of a decreased pulse rate with a rising general pressure, which

would not only allow the velocity-work ratio to remain unchanged, but which need not necessarily add materially to the work of the heart. As a matter of fact, this is precisely what does occur within certain limits under normal conditions. To show this, it is only necessary to note the effect of change in posture upon blood-pressure and pulse rate, as discussed on page 00.

The normal arterial tree will withstand a continual variation in pressure of from 35 to 50 mm. without undergoing pathologic change. Under those conditions in which we have a pulse-pressure of more than this, it is evident that the blood-vessels are required to withstand undue stress; and so if we here subtract the normal pulse-pressure from the pathologic, we have relatively the measurement of the increased working of the heart. Now if this difference is multiplied in turn by the pulse rate per minute, then by 60 and by 24, it is very easy to see the relatively tremendous excess of work and energy required of the heart in every 24 hours in order to maintain circulation and nourish the tissues. This would seem to be the true explanation of heart hypertrophy, arterial change and ultimate cardiac dilatation with failing circulation.

Lauder Brunton says "The diastolic pressure is a factor of great importance, because by its amount and by the difference between it and the systolic pressure we obtain valuable data in regard to the strength of the heart and the condition of the arterioles."

v. Pachon was among the first to express the belief that the normal systolic pressure was not only of uncertain value in the study of many pathologic cases, but that its variation within wide limits and at short intervals for any individual, even slight physiologic

causes, might be actually misleading, as under the following conditions: In decompensated cardio-renal cases where the maximal pressure may be normal, it is only by determining the abnormal elevation of the diastolic pressure and consequent reduction in pulse-pressure that we are able to clinically confirm the circulatory fault.

The minimum pressure represents the true constant load borne by the arterial tree and the resistance which the heart is obliged to overcome before its contents can be expelled. Both data of fundamental importance from the clinical pathologic standpoint. It has been found also that the diastolic pressure is a far more constant factor in normal individuals than the systolic, that it is practically the same for all parts of the arterial tree, while the maximal pressure drops progressively from aorta to periphery.

W. R. Sheldon, *Medical Record,* December 31st, 1910, adds the following to our already rapidly increasing information:

The lessened elasticity of the arteries which is found in many conditions contributes to an abnormal relation between the diastolic and systolic pressure, so that in long-continued high blood-pressure, due to lessened elasticity in the artery, there is a failure of the diastolic pressure to maintain its normal relation. The pulse-pressure is increased and we can, by the formula already described, estimate the amount of extra work which is demanded by the high pressure incident to arterial rigidity. From these we can draw the following corollary, which is, that increased strain on the heart is to a large degree measured by the amount of diastolic failure, i. e., the larger the pulse-pressure in

relation to the diastolic pressure, the greater will be the cardiac strain, which finally fails to respond to the increased demands and enters into a condition of decompensation. So that we may look for signs of poor circulation when there is a high systolic pressure and a diastolic pressure that is relatively low; and conversely, if measures directed toward removing the cause of this abnormal relation are successful, we may measure the amount of improvement by the elevation of diastolic pressure and consequent reduction of pulse-pressure, as is well shown in the case above described.

These two formulas have been discussed at some length because of their fundamental importance and wide applicability. By means of these, it is a simple matter to compute the excessive work required of the normal heart under varying conditions of strain and load, and also in those pathologic conditions of the circulation accompanied by changes in the heart, blood-vessels and kidneys. Anyone who appreciates the value of the blood-pressure test will find these studies of great assistance in diagnosis, prognosis and treatment.

The following case from actual practice shows the method of its employment and the information derived:

Case of Chronic Myocarditis and Arteriosclerosis.

Before treatment—S. P. 210, D. P. 100, P. P. 110, P. R. 104.

$$\left.\begin{array}{l}\text{S. P. (210)} \times \text{P. R. (104)} = \text{Work (21840)} \\ \text{P. P. (110)} \times \text{P. R. (104)} = \text{Velocity (11440)}\end{array}\right\} = \text{ratio 1 to 2.}$$

After two weeks' treatment—S. P. 195, D. P. 140, P. P. 55, P. R. 84.

S. P. (195) × P. R. (84) = Work (14580)
P. P. (55) × P. R. (84) = Velocity (4620)
} = ratio 1 to 3.

Here, under proper methods of treatment, the work-velocity was greatly benefited, the actual work reduced one-third, so that while the heart was at first only able to maintain the needs of the case under serious strain, and accompanied by evident signs of cardiac distress. After two weeks the danger of acute failure of the circulation was overcome and the whole complexion of the case altered for the better.

In pneumonia and most infectious diseases a falling blood-pressure with a narrowing pulse-pressure means great danger. A wide pulse-pressure is found in arteriosclerosis, with loss of elasticity in the blood-pressure and with increased peripheral resistance; in chronic interstitial nephritis, and is very wide in aortic insufficiency, in fact, it is often pathognamonic of this condition. Dr. George Oliver says that of the two he has come to consider the diastolic pressure just as precise as the systolic and more valuable.

CHAPTER II.

THE CIRCULATION.

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The application of instruments of precision for the study of conditions of the circulation marks an epoch in the history of medicine. The application of scientific instruments in clinical medicine has developed a large amount of valuable information concerning the relation of the heart, blood-vessels and kidneys, in both normal and pathologic conditions. We are now able, by means of easily applied tests, to gather accurately and quickly an enormous amount of detailed information which could have been found by no other means.

This general increase in knowledge of special diseases has placed an added amount of responsibility upon the medical profession, for the public has so learned to appreciate the benefit to be derived from this broader knowledge, that patients now demand special methods of examination and study, in every case, far greater than was ever dreamed of twenty years ago.

Among the many scientific instruments now employed in the study and practice of medicine, there is probably not one single instrument of greater use and of easier application than the sphygmomanometer. Its value has now become so fully established that it needs no argument to show an intelligent physician

that the sphygmomanometer is a most important part of his armamentarium.

In taking up this discussion of blood-pressure apparatus and blood-pressure tests, it is only necessary to call attention to the fact that the normal circulation is a vital function necessary in the maintenance of health and that the cardio-vascular system is involved to a more or less degree in the great majority of diseased conditions. It is evident that the knowledge of the condition of the heart and circulation plays an important part, not only in diagnosis, but in prognosis and in treatment.

In taking up the consideration of the subject of blood-pressure, a brief review of the physiology of the circulation is essential in order that departures from it may be recognized and that these changes may be given their proper value in the general symptom-complex.

Roughly speaking, the heart and arteries may be likened to a force pump and series of elastic tubes, which supply every part of the body with nutrition, remove waste products and at the same time contribute to the size and density of the organs. The heart is a compound pump of intermittent action. From this springs the aorta, which rapidly ramifies from the heart to the periphery. The aorta receives blood from the heart in intermittent jets, and this would be transmitted to the periphery in the same intermittent manner were it not for the elasticity and other vital properties of the blood-vessel walls.

The mechanism of the circulation is largely concerned in reducing this intermittent stream to the continuous flow found in the organs and capillaries. It

is also concerned in maintaining the proper supply of blood to each part as the demand may arise for increased nutrition. In order to accomplish this function, it is essential that the blood should be maintained under a certain degree of pressure. This is necessary to insure the proper distribution and to bring an increased supply to any particular region when demanded. This relation is maintained by what is known as blood-pressure.

Normal blood-pressure depends upon the normal correlation and interaction of certain variable factors: (1) The amount of blood pumped into the arterial system by the heart. (2) The resistance offered to the escape of blood toward the periphery through the smaller arteries and the capillaries. Of less importance are (3) the elasticity of the vessel walls, (4) the total quantity of blood in the body, and (5) viscosity. These factors are all capable of interaction in the most complicated manner. For example, if the arterial pressure is increased from any cause, the vagus nerve is stimulated, and the effect of its inhibitory action upon the heart is to lower the heart rate so that less blood is delivered into the aorta in a given time, thus assisting to maintain normal blood-pressure. In like manner, when the volume of blood is rapidly reduced from hemorrhage or venesection, the blood-vessel reflex immediately reduces the calibre of the arteries, so that within certain limits the blood-pressure is not altered.

TERMS AND DEFINITIONS.

Having briefly reviewed the physiology of the normal circulation and the causes concerned in the production and maintenance of blood-pressure, we may

now proceed to a consideration of the relation of these facts to the problems of clinical medicine and their bearing on Diagnosis, Prognosis and Treatment.

To obtain a clear insight and understanding of the subject it is all-important to have an accurate knowledge of the terms applied to the matter under consideration.

The Pulse.—The pulse is a rythmically recurring impulse arising in the systole of the left ventricle, and palpable through the arterial system. Its presence indicates a variation in blood-tension within the arteries, which causes them to pulsate, as the walls momentarily expand.

Blood-pressure.—Blood-pressure is the term employed to indicate the degree of pressure under which the blood exists while traversing the arteries. Unless otherwise specified, the term blood-pressure as used throughout this book indicates arterial systolic blood-pressure.

Systolic Blood-pressure. — Systolic blood-pressure means the degree of arterial pressure or lateral tension existing in the arterial system at the moment of cardiac systole.

Diastolic Blood-pressure.—Diastolic blood-pressure means the degree of arterial pressure or lateral tension existing in the blood-vessels just preceding a systole of the heart. This represents the time when the blood-pressure is at its lowest.

Pulse-pressure, Range or Amplitude.—These synonymous terms indicate the amount of periodic variation in blood-pressure occurring within the arterial system, due to the intermittent action of the heart. It is equal to the difference between systolic and diastolic blood-pressures as determined by the sphygmomanometer.

Mean Tension.—Mean tension is the term applied to indicate the average strain to which the arterial system is subjected. It corresponds closely to the arithmetical mean of the systolic and diastolic blood-pressure. The relation between these several terms and normal pulse tracing is shown in Fig. 1.

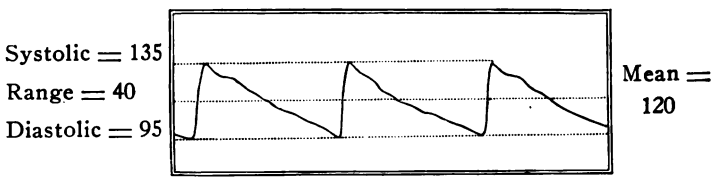


FIG. 1—Normal pulse tracing; showing relation of systolic, diastolic, pulse-pressure and mean. Pulse-pressure equals 40.

Normal Tension.—This term applies to the systolic blood-pressure which should be found in a normal individual as determined by the study of a large number of persons. This pressure is modified by a number of normal or physiological conditions, and is therefore subjected to some variation. Full discussion of these will be taken up in Chapter IV page 54.

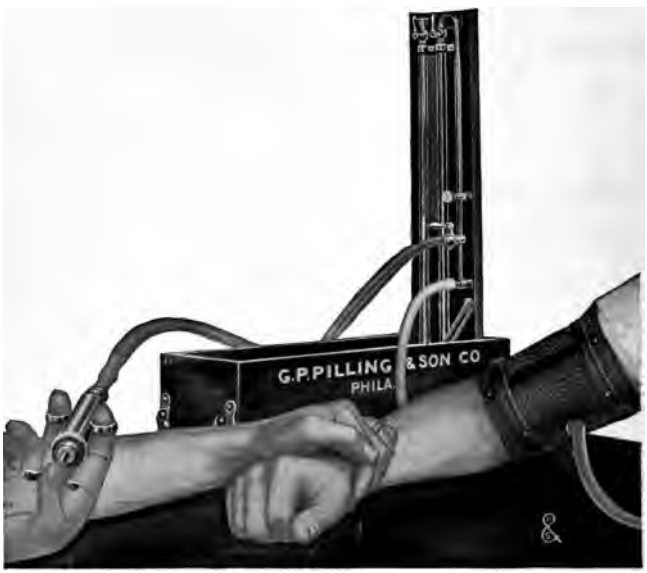
Hypotension.—Hypotension is the term applied to the condition of the circulation in which the systolic blood-pressure is found to be below the normal as estimated for the individual.

Hypertension.—Hypertension is the term applied to a condition of the blood-pressure when the level is maintained above the estimated minimum normal pressure.

Auscultatory method.—By this is meant a method of determining both the systolic and diastolic blood-pressure, with the aid of a suitable stethoscope (as the Bowles Midget or the sphygmometroscope, see page 41), the bell of which is placed over the bifurcation of the brachial artery at the bend of the elbow below the sphygmomanometer cuff.

CHAPTER III.

THE SPHYGMOMANOMETER.



Pilling-Faught Standard Mercury
Sphygmomanometer in use.

CHAPTER III.

THE SPHYGMOMANOMETER.

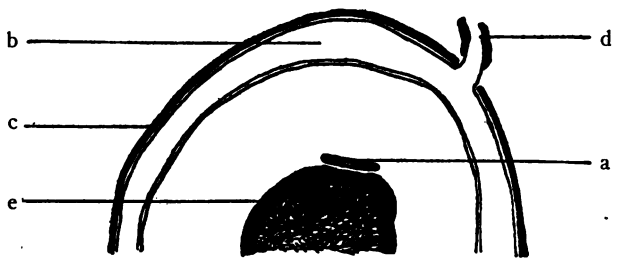
The Principle of the Sphygmomanometer.

Vital tissue is perfectly elastic. Therefore any pressure applied to the surface of the body will be directly transmitted to the underlying structures without loss of force. It is upon this principle that the indirect method of measuring the blood-pressure is based.

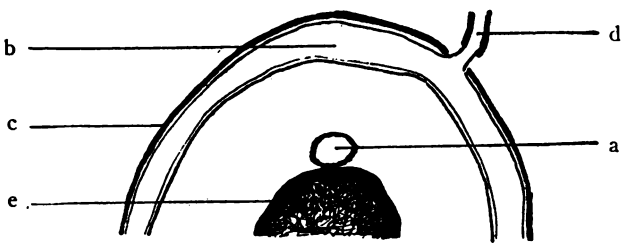
Pressure is applied to an accessible part of the body over a large blood-vessel, such as the brachial. If the amount of this pressure is sufficient to overcome the pressure of the blood within the vessel, the vessel will be collapsed and the pulse prevented from passing beyond it. If the amount of the compressing force is measured and expressed in definite terms of weight (as millimeters of a column of mercury) then we can, by applying just sufficient pressure to collapse the vessel, measure the amount of force exerted by the blood in preventing this collapse.

In practice the pressure is produced by a cautery bulb or a small hand pump, and applied to the arm by means of a hollow flat rubber bag. This is applied about the arm and held there by some form of inelastic cuff. Communication with a suitable manometer measures the amount of pressure applied to the vessel.

Fig. 2, A and B, shows the relation of the compressing bag to the artery. In Fig. 2, A, the pressure within the cuff is greater than the blood-pressure within the artery, which is therefore collapsed and the pulse in the distal end of the vessel cut off. In



A.—Pressure in "b" 135 mm. Hg.; pressure in "a" 130 mm. Hg. B is therefore collapsed, pulse cannot pass.

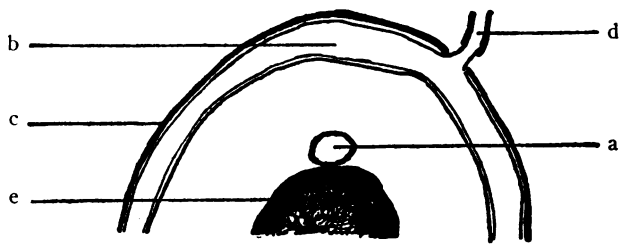


B.—Pressure "b" 129 mm. Hg.; pressure in "a" 130 mm. Hg. Pulse passes.

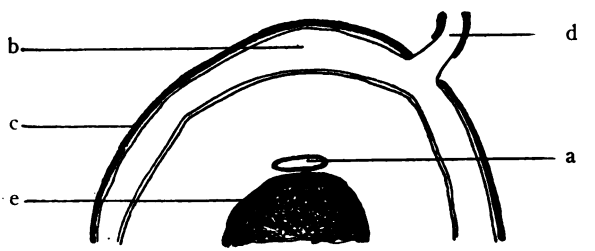
FIG. 2—Diagram of relations of armlet to brachial artery. Explanation of systolic reading; a, artery; b, compressing armlet; c, retaining cuff; d, tube to manometer; e, humerus.

Fig. 2, B, the pressure in the cuff has been reduced so that it is a fraction of a millimeter less than the systolic pressure within the vessel. Now at each systole a small amount of blood will pass the con-

striction and will reach the distal end of the artery, where the wave can be felt by the palpating finger at the wrist.



A.—Systolic pressure in "a" 130 mm. Hg.; pressure in "b" 101 mm. Hg. Artery not compressed.



B.—Diastolic pressure in "a" 100 mm. Hg.; pressure in "b" 101 mm. Hg. Artery collapsed.

FIG. 3—Diagram of relation of armlet to brachial artery. Explanation of diastolic reading; a, artery; b, compressing armlet; c, retaining cuff; d, tube to manometer; e, humerus.

Fig. 3, A and B, represents the conditions existing between the constricting cuff and the vessel at the time of diastolic pressure. A represents a pressure within the cuff less than the systolic pressure in the

vessel. This is insufficient to affect the vessel during the systolic period. B shows the artery and cuff during the diastolic period, when the pressure within the artery is at its lowest point, a fraction of a millimeter less than the pressure within the cuff. Consequently the artery is collapsed at this time. The effect of each succeeding systole is to alternate between a round and a flat vessel at the point of compression. This affects the pressure of the air within the cuff, which is in turn transmitted to the mercury column of the manometer and becomes visible in the rhythmic fluctuation of the column of mercury which is synchronous with the pulse beat. Since the fluctuation will reach a maximum at the time when the pressure in the cuff is approximately equal to the diastolic pressure in the vessel, we are justified in considering the base of the manometer column at this time a measure of the diastolic pressure within the vessel.

Since the development of the visual or oscillatory method of diastolic blood-pressure observations newer and better methods have been designed. These are the tactile, the auscultatory and that by means of the Fedde indicator attachment. Each of which will be considered more fully later under the head of "application of the blood-pressure test."

Description of Apparatus.—At the present time the market is flooded with instruments of all descriptions for estimating blood-pressure, so that it is important that the prospective purchaser should be able to separate the good from the bad, since the imperfect and poorly constructed instrument will be a constant source of inconvenience and may give very incorrect readings.

All these instruments may be roughly divided into two classes: First, those dependent upon the weight of a fluid column (usually mercury) which measures the pressure; and, second, those employing some form of spring or aneroid chamber.

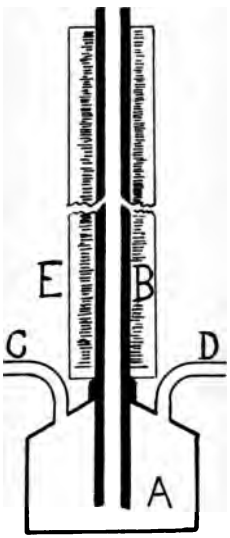


FIG. 4—Type of Mercury Manometer employing a vertical tube. A, mercury-containing base; B, manometer tube; C, tube to armlet; D, tube to bellows; E, scale.

Taking up the first class, we find that this can be divided into two divisions; one employs a vertical glass tube emerging from the mercury chamber so that when pressure is exerted on the mercury, it is forced upward into the glass tube, where the pressure is indicated in millimeters of mercury by an appropriate scale attached thereto (see Fig. 4).

The second group of mercury instruments employ a glass U-tube similar to that first used by Poiseuille

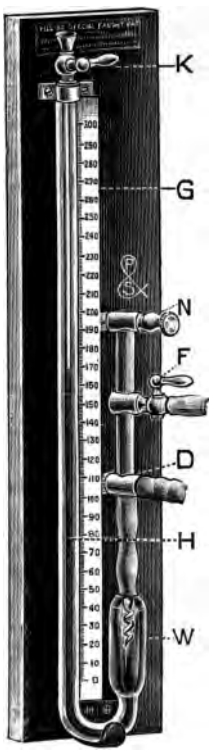


FIG. 5 — Manometer Arrangement of Pilling Special Sphygmomanometer.

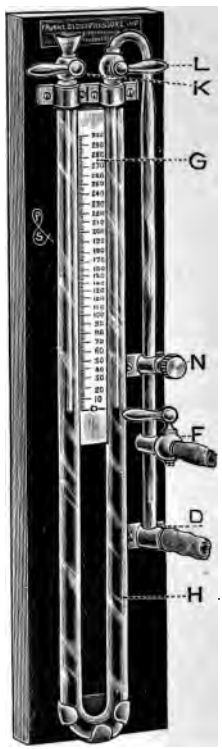


FIG. 6 — Manometer Arrangement of Faught Standard Sphygmomanometer.

(see Fig. 6), with the open ends up. This tube is partly filled with mercury and one limb is connected by means of suitable tubing with the rest of the

apparatus. Pressure exerted within the system will cause the mercury to rise in one limb of the tube with a proportionate fall upon the other. The difference in the level of the mercury in the two limbs will represent the pressure, which may be measured by a suitable scale placed between the tubes.

These two types depending upon a vertical column of mercury have little to choose between them, and both are accurate and trustworthy at all times. The mercury at rest freely communicates with the atmosphere, and is therefore not affected by barometric or thermometric changes.

A question has been raised by some regarding the accuracy of the cystern-vertical-tube-type of mercury sphygmomanometer in the high readings. It has been found that the fall in the mercury level in the cystern affects slightly the total height of the mercury column, so that in readings above 250 the figure obtained with this type of apparatus may be from 5 to 10 mm. too low. After all, this is not such a great drawback, as the variation is slight at best, and because such pressures are but rarely met in the course of general practice.

VALUE OF MERCURY APPARATUS IN DETERMINING DIASTOLIC PRESSURE.

Some time ago there appeared an article in which the value of the fluctuation of the mercury column for determining diastolic pressures was questioned; this was based upon the supposed interference of the inertia of the mercury column. The author of these statements failed to recognize the fact that the mercury column at the time of the observation was under

an added factor of pressure and that this pressure exerted against the mercury column greatly reduced the enertia factor. *By experiment it was found possible for the mercury column to show a fluctuation from successive systolies up to nearly 200 beats per minute,* or more than twice the number possible with a mercury column moving freely in the atmosphere. Anyone, by actual experiment, can demonstrate this with any form of mercury apparatus, so that one need not fear to use a mercury apparatus when employing the visual method for diastolic reading, unless the pulse is so rapid that it is uncountable; this does not mean that the visual method is recommended, but simply that when no other means is available, the results by this method will be reasonably accurate and clinically satisfactory.

Aneroid or Pocket Type.—There are also several types of instrument, employing some form of spring and aneroid chamber, actuating a dial indicator for the recording of blood-pressure in millimeters of mercury. These are the so-called pocket instruments, and have much to recommend them, provided they do not become inaccurate by use.

The Faught Pocket Sphygmomanometer consists of a gold-plated aneroid gauge with a white enamel dial bearing black and red markings graduated to 300 mm. Hg., a strong flexible sleeve and a metallic inflating pump, together with suitable rubber tubing for connections. When assembled these constitute a very simple and most reliable instrument, so compact that it is contained in a leather case, measuring 8 x 3½ x 1½ inches, and weighing complete about one-half pound, fitting easily in the pocket or bag.

This instrument has been devised to fill the long-felt need of a Pocket Sphygmomanometer, which would combine portability and accuracy with durability and strength. The Faught Pocket Sphygmomanometer is an exact and efficient instrument, and is employed extensively by life insurance examiners, hospitals, the army and navy, bureaus of health and by most of the leading practitioners. It is compact, absolutely accurate, very sensitive, substantially constructed, and with ordinary care should last a lifetime.

It is unfortunate for the medical profession that a certain type of aneroid type of instrument which at first met with favor has been found in many cases to lose its accuracy and to become untrustworthy through frailty of construction, which renders it easily deranged. Even ordinary use will at times develop in this particular make of instrument permanent inaccuracy.

Failure of a single type should not, however, condemn all instruments operating upon the aneroid principle, as the test of time so far has failed to show any such disturbance in the aneroid made by the Pilling Company; for example, *a Faught instrument* was used for ward class demonstration for more than a year, and when tested with the original standard mercury column *was found as absolutely accurate as when originally tested.* At another time, after one hour's constant use on about twenty students, a test for accuracy was immediately made, and the readings corresponded absolutely, both up to 300 and down again. THIS PROVES CONCLUSIVELY THAT THE FAUGHT POCKET SPHYGMOMANOMETER IS NOT AF-

FECTED BY CONSTANT USE AND THAT READINGS BOTH UP AND DOWN ARE IDENTICAL. No other aneroid can bear these tests.

J. F. Prendergast, commenting upon the accuracy of the Faught Pocket Sphygmomanometer, states: "As FOR ACCURACY AND DURABILITY, THE WRITER HAS FOR THE PAST FOURTEEN MONTHS USED ONE ANEROID INSTRUMENT, A FAUGHT, AND HAS FORCED IT UP TO 450 MM. NEARLY TWO THOUSAND TIMES. AFTER THIS SEVERE TEST IT WAS COMPARED WITH A STANDARD MERCURY COLUMN AND FOUND AS ACCURATE AS AT THE ORIGINAL TEST. IT IS STILL IN SPLENDID WORKING CONDITION, AND THE COMPRESSION DIAPHRAGMS ARE AS RESILIENT AS THE DAY IT LEFT THE PILLING FACTORY. THIS IS A TEST OF THE MOST SEVERE CHARACTER, AND ANY INSTRUMENT THAT WILL REMAIN ACCURATE WITH SUCH USAGE WILL LAST INDEFINITELY WITH ORDINARY USE."

FIG. 7.—Faught Pocket Sphygmomanometer in Case.

A very important and distinctive feature possessed by the Faught Pocket Sphygmomanometer and found

in no other instrument of similar character is the absolute elimination of the so-called "fatigue of metal" which heretofore has interfered with the accuracy of all other aneroid instruments. By persistent experiment and painstaking study a material for the construction of the compression disks has been found which is not affected in any way by temperature or pressure variations.

These tests can be repeated by anyone and the results will be the same. Try them and be convinced.

The Arm-band is made of strong grey inelastic, but soft and flexible material, having between its layers a rubber bag 9 x5 inches. This measurement conforms to the requirements of Janeway and others, and has been found to give the most accurate readings under all conditions.

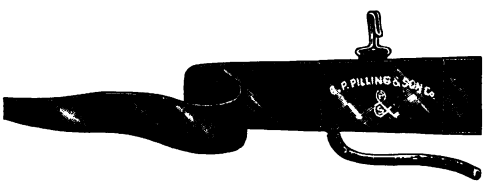


FIG. 8.—Arm-band.

The Faught Pocket Sphygmomanometer can be applied or removed in less than thirty seconds. The time required to apply the instrument, make a careful observation of the pressure and remove it is less than consumed by any other form of sphygmomanometer on the market.

Two years' experience with the Faught Pocket Sphygmomanometer has demonstrated conclusively

the superiority of the internal mechanism of this instrument as compared with all other types of aneroid. They have been found practically indestructible as well as uniformly correct. Many instruments in constant use—thousands of times—coming back for examination, are found to have retained their accuracy when compared with the standard mercury column.

FIG. 9.—Pocket Indicator. Actual size.

For accuracy and sensitiveness, the Faught aneroid has all the advantages of the best mercurial instruments; for compactness and durability it far surpasses them. It is practically indestructible, and is well adapted to use in the operating room and in private practice, as well as in hospital service.

Reads up to 300 mm.—The dial, which is accurately graduated, reads in mm. Hg., as does the standard mercury column, each interval representing two mm., and ranges from zero to three hundred (Fig. 9).

The dial also may be revolved without interfering with the internal mechanism, so that the pointer at rest can be adjusted to zero. *Neither temperature nor atmospheric variation in any way affects the apparatus,* since when at rest the pressure on both side of the pressure chambers is equalized.

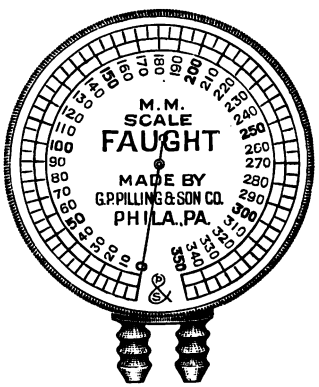


FIG. 10.—Clinical Pocket Sphygmomanometer. One-half actual size. Diameter of dial, 3¼ inches.

The latest development in sphygmomanometers is the **"Faught Clinical."** This instrument follows a new principle which has been fully tried during several years in the Faught Pocket Indicator, and which has been fully demonstrated to be the most desirable and accurate multiple chamber aneroid instrument yet designed.

This instrument is shown in detail in Fig. 10.

The two characteristic features of this instrument are the large, easy-to-read dial, measuring 3½ inches working diameter, and a graduated scale with a **range of 350 mm. Hg.** The first and only sphygmomanometer to have a range sufficient to give accurate readings in every case, as it is now well established that pressures are not infrequently encountered that register well above 300 mm. (See article in *New York Med. Jour.,* June 11, 1910, by John C. Hirst.)

In general appearance the Clinical very much resembles the Pocket and, in spite of the larger scale, is contained complete with pump and arm-band in a case but very little larger than that of the Pocket Indicator.

The Faught Standard Mercury Sphygmomanometer is modeled after the U-tube type of apparatus and is designed to overcome the defects of the earlier instruments, to meet every requirement demanded of a modern sphygmomanometer and at the same time be easy to use, difficult to derange and as light and portable as is compatible with accuracy and strength.

The mahogany case, which encloses the complete apparatus, including the arm-band (see Fig. 11) and pump (see Fig. 16), measures 4 x 4½ x 16 inches and weighs 3 pounds 9 ounces. The lid is hinged at one end and when raised supports the working parts of the apparatus. A spring check allows the lid to be raised to a vertical position, where it is automatically held locked during the observation.

The "U" tube is provided with a scale which has been arranged to give the reading directly in millimeters of mercury.

A special and distinctive feature of the apparatus is the means of preventing loss of mercury from the manometer tube when the instrument is not in use. This is accomplished by means of two small cocks placed at either extremity of the "U" tube, and which are kept closed when the apparatus is not in use (see Fig. 6).

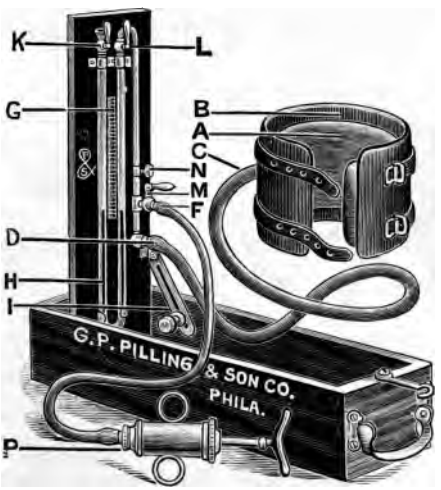


FIG. 11—Faught Standard Sphygmomanometer.

By eliminating all detachable parts, the time required to make the reading is reduced to a minimum. The only preliminaries to the test being to lift the lid, open three cocks and attach two tubes to their respective nipples.

To Operate the Faught Pocket and the Faught Clinical Sphygmomanometers.

Apply the arm-band to the bared arm of the patient, above the elbow, by placing the broad end, containing the rubber bag, over the region of the brachial artery. Wrap the rest of the band as you would a bandage about the arm (see Fig. 12) and tuck the narrow end in under the first turn. Attach the indicator to the hook provided for that purpose; attach the pump to one nipple, and the tube from the arm-band to the

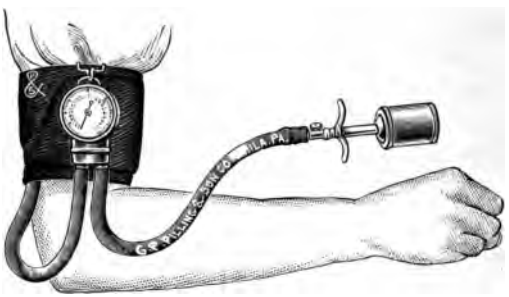


Fig. 12.—Pocket Indicator Applied to Arm.

other. See that the needle valve on the pump is fully closed. Hold the pump in one hand and locate the pulse at the wrist with the other. You are now ready to take the systolic pressure.

To obtain systolic reading.—Pump sufficient air in the system to obliterate the pulse, then by a fraction of a turn open the valve (see Fig. 12), gradually release the air pressure, and note the pressure indicated when the first pulse beat returns to the wrist. This is systolic pressure. Repeat the procedure one or more times to insure correct readings. Work rapidly, as prolonged pressure upon the arm will affect the reading.

To obtain diastolic reading.—Again obliterate the pulse and allow the air pressure to gradually fall through the needle-valve. As the pressure falls the needle will be seen to fluctuate in rhythm with the pulse; after a time this movement will become less and eventually disappear. The pressure indicated on the dial at that time will be the diastolic pressure.

Obliterate the radial pulse, then gradually reduce the air pressure; when the pulse returns to the wrist it will at first be very feeble and thready, then it will come up full and strong under the finger. Take the reading at the moment the pulse becomes full and normal in character. This will be the diastolic pressure.

The value of correctness of the ausculatory method of determining blood-pressure has, during the last few years, been conclusively demonstrated. This was first introduced by Korotokoff, of St. Petersburg, in 1905, who, instead of using the finger upon the radial pulse, substituted the stethoscope applied over the brachial artery at the bend of the elbow. On the return of the blood under the armlet, a distinct throbbing becomes audible, which gradually increases in loudness as the pressure in the cuff lessens, and then gradually dies down and disappears when the artery ceases to be obstructed at any time during the heart cycle.

The chief advantage of the auscultatory or auditory method is in that it gives not only the high point—the systolic pressure—very definitely, but also the low point—or diastolic pressure, a point of great value, since it is well recognized that, under many conditions by the older methods, it is impossible to obtain

any accurate diastolic pressure, and in some cases no diastolic reading at all.

The importance of this is further emphasized by the fact that the diastolic pressure is often the more important reading, since it gives the pulse pressure or amplitude, which is an indication of the actual force and volume of the circulation. Clinical studies by Goodman and Howell in the *American Journal of Medical Science,* 1911, and by Warfield and by H. G. Armstrong in the *Journal of the A. M. A. and British Medical Journal,* are sufficient to assure us of the value of the auscultatory method. For the benefit of those who desire to go into this study more extensively than is really necessary for clinical work, the following analysis of the sounds is given.

These consist of five phases, which are clean cut and which have a definite relation to the differences between the extremes of pressure. With a normal systolic pressure at 130 mm. and a diastolic pressure at 85, the phases are:

First, a loud, clear, snapping tone, which is the first phase. This serves as an index as to how far the pressure must fall before the column of blood can be sustained past the obstruction in the vessel caused by the cuff, at sufficient velocity and for sufficient duration to produce the murmur. Normally this phase covers 14 mm., and any increase or decrease in length should be noted. The advent of this sound indicates the systolic pressure.

The Second Phase consists of a succession of murmurs, covers 20 mm. and is dependent upon cardiac effectiveness.

The Third Phase is a tone resembling the first phase, but less marked and lasts 5 mm. This is dependent upon cardiac efficiency and also upon the character of the vessel wall. The more sclerotic the vessel and the greater the cardiac hypertrophy, the more favorable are the conditions for the production of a clear tone at this time.

The Fourth Phase occupies about 6 mm. and is heard as a dull tone; a resilient vessel receiving a normal pulse shock, or a rigid vessel receiving a weakened shock. The pointer at this time indicates the diastolic pressure.

The Fifth Phase is the disappearances of all the sounds.

Of these three methods, the last is the more accurate and scientific. One point, however, must be borne in mind: readings in the text books and medical literature are based on the first and second methods. The auscultatory method will give readings of a slightly higher systolic pressure and a diastolic pressure of 10 to 15 mm. lower.

Having determined the systolic pressure and the diastolic pressure, the diastolic pressure is subtracted from the systolic pressure and the remainder is the pulse-pressure (see Fig. 1, page 19).

To obtain the **mean pressure,** add one-half of the pulse-pressure to the diastolic pressure (see Fig. 1),

In order to enable physicians to take the blood-pressure readings more accurately and to make them of greater clinical value to the profession as a diagnostic and therapeutic guide, Dr. J. F. Prendergast (*N. Y. Med. Jour.,* Jan. 11, 1913) has had devised and placed on the market the *Sphygmometroscope* (Aus-

culoscope). It consists of a two-inch band, to which is attached a metal bowl or cup, the face of which has a very delicate diaphragm, with a centre projection to fit more snugly to the surface of the arm over the brachial artery, just at or below the bend of the elbow. Flexible rubber tubes are connected with the

FIG. 13.—Method of auscultatory blood-pressure test, using Faught pocket indicator and sphygmometroscope.

drum or body of the instrument, to which are attached hard-rubber ear-pieces (see Fig. 14). It is called the Bowles sphygmometroscope, and resembles the Bowles stethoscope with certain modifications; it is attached to the arm by a two-inch band.

The instrument is intended for use with any kind or form of sphygmomanometer, either pocket or mercury. Its method of application is to place the band on the arm one or two cm. (one-half to one

inch) below the arm-band or cuff of the sphygmomanometer at the bend of the elbow, having the projection on the diaphragm of the drum directly over the brachial artery before it divides into the ulnar and radial. Care should be taken to avoid pressure from this band upon the arm.

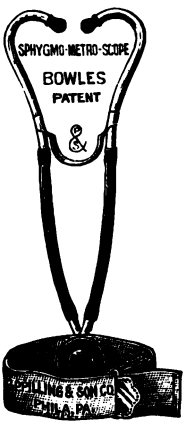


FIG. 14.—Sphygmometroscope.

Pump the cuff, connected with the manometer, with air until the radial pulse is cut off, open the release valve and allow the air to escape slowly from the arm-band. The first impulse or sound heard is a clear thump or tap, caused by the sudden stretching of the walls of the relaxed vessel and the rapidity of the blood stream. This is the systolic pressure.

Where one is merely trying to read the systolic and diastolic pressures, it is not necessary to attempt to interpret the different phases. *The essential thing to remember is that the first tap or sound is the systolic pressure, and just at the disappearance of all sounds is the diastolic pressure.*

Goodman and Howell say: "The auscultatory method is useful in differentiating certain organic and functional derangements. It was found that any arrhythmia which may be present is noted earlier by

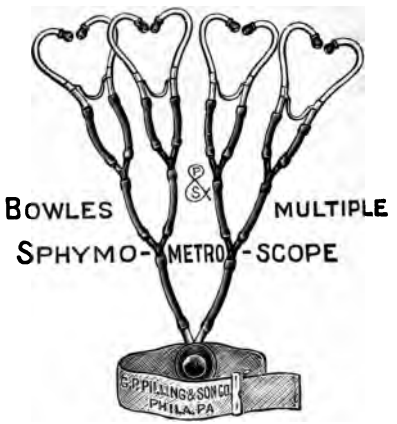


FIG. 15.—The Multiple Sphygmometroscope.

the auscultatory method than by feeling the pulse or listening to the heart. By this method true organic cardiac lesions can be differentiated from a neurosis. In organic lesions there is a uniformity in sequence of readings; in neuroses the readings are marked by variations in sequence and a variation in the systolic and diastolic pressures."

The Multiple Sphygmometroscope.—The accompanying illustration, Fig. 15, represents a new device to facilitate the teaching of blood-pressure readings by the auscultatory method. The chief drawback to the ausculatory method has been the seeming difficulty which the average physician has in learning to perceive and interpret the sounds heard over the artery.

The idea suggested itself that if the sphygmometroscope were made into a multiple of four, whereby the sounds could be heard by more than one individual at the same time, it would overcome this difficulty and make it possible for anyone familiar with the sounds heard during auscultatory blood-pressure observations to direct the attention of a small group of observers during the actual performance of the test.

The G. P. Pilling Company, of Philadelphia, have taken up this suggestion, and this valuable instrument is now upon the market.

The device will be valuable particularly to the medical teacher, as it has been our experience that many students go through their clinical studies without ever actually hearing or seeing what is demonstrated. It is serviceable also in demonstrating to medical societies or groups of medical men conditions involving marked variations in pressure.

TO OPERATE THE STANDARD SPHYGMOMANOMETER.

The patient should be in a comfortable position and in a sitting or reclining posture. The instrument should be upon a level surface within easy reach of the examiner.

The lid is then raised until it locks in a vertical position. If the tube from the pump is not already connected to the nipple F, it should be firmly attached to it. The two mercury guard cocks K and L at the ends of the "U" tube should be opened and the escape valve N tightly closed.

The hollow rubber bag of the arm-band A should be firmly wrapped around the bared arm of the

patient and securely bound there by the leather cuff and straps B (see page 89). The cuff should be applied snugly, but not with pressure, as it is not designed to compress the member, but only to restrain the inner rubber bag while pressure is applied to it.

The tube from the arm-band C is attached firmly to the nipple D. The cock in the nipple F is opened.

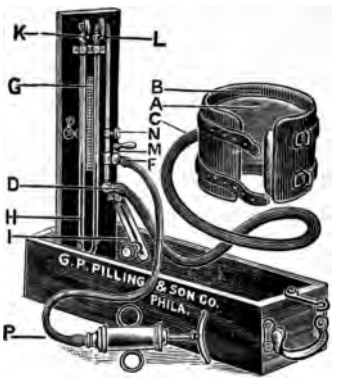


FIG. 16.—A, inner arm-bag. B, outer retaining cuff. C, tube from arm-band. D, nipple for tube from arm-band. P, pump. F, nipple for pump tube. G, millimeter scale. H, manometer tube. I, link-brace and lock. K, mercury guard cock. L, mercury guard cock. M, pressure guard cock. N, release valve.

This arrangement forms a continuous closed pneumatic system communicating freely with the manometer tube of the instrument. Now when pressure is raised in the arm-band by the hand-pump, the amount of force exerted is indicated by the rise of the right-hand column in the manometer tube H, the height of which will be indicated on the scale G in millimeters of mercury.

Systolic Reading.—With one hand find the pulse at the wrist of the arm, to which the arm-band has been

applied. The fingers should be in a comfortable position and under no circumstance should be moved during the observation. Care should also be observed that the pulse is not cut off by undue pressure of the palpating fingers. The cuff should be in the same horizontal plane as the subject's heart.

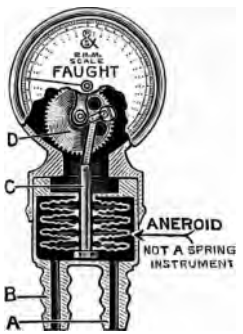


FIG. 17.—Diagram of internal mechanism, showing compression chambers.

Note the fact that in this instrument the pressure itself is applied on the outside of the metallic chambers, so that they are compressed and not expanded, in proportion to the degree of compression force exerted.

While the pulse is thus under observation, the pressure in the apparatus is raised by means of the hand bellows or pump until the pressure within the constricting band is sufficient to prevent the impulse from reaching the wrist. When this is accomplished the cock in the nipple M is closed to eliminate the elastic pressure. Now by a fraction of a turn in the valve N the pressure in the system is slowly released. During this part of the procedure, a close watch

should be kept upon the height of the mercury column and for the return of the first pulse beat at the wrist. The level of the mercury column at the instant that the pulse passes the compression-band will represent the systolic pressure in the vessel under observation. It is advisable to repeat this procedure a few times to check the correctness of the finding.

The **diastolic pressure** may be obtained in several ways. The method employed will depend upon the character of the instrument used and the method preferred by the operator. The readings obtained by this instrument correspond closely to those obtained by auscultation. The methods will be described in the order in which they have been devised.

The visual method depends on the to-and-fro motion imparted to the mercury in the "U" tube, which occurs after the pressure has fallen below the systolic point. Having determined the systolic pressure, again raise the pressure to a few millimeters above this point and immediately close the valve M. Now allow the pressure to fall very slowly by releasing the air through the valve N.

As the mercury falls below the systolic point it will be noted that it acquires a rhythmic motion corresponding in time to the pulse. This will be found to gradually increase in amplitude up to a certain point, after which it decreases and finally ceases before zero pressure is reached. During this gradual fall the base of the mercury column, when the mercury is making the greatest excursion, represents the diastolic pressure.

These are the same as are described under Pocket Apparatus on page 36.

By Diastolic Indicator.—This is very similar to the visual method, except that the movement of the mercury column is ignored and the movement of the pith ball in the small vertical tube relied upon to determine the diastolic pressure.

By reference to Fig. 18 it will be noted that the narrow perpendicular glass tube contains a small, light ball of pith or cork, which is free to move up and down within the tube.

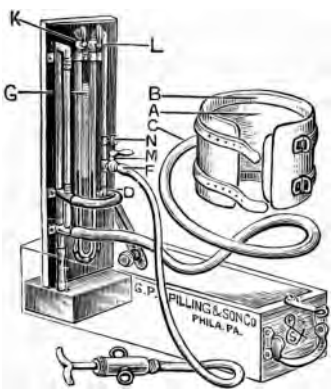


FIG. 18.—Fedde Indicator as Component of Standard Sphygmomanometer.

When determining the systolic pressure pay no attention to this indicator, as each impact of air will make the ball dance violently, but this has no bearing on the test. When the pressure has reached the systolic point, close the valve N, when the ball will begin to move slightly in rhythm with the pulse. This motion gradually increases, until it reaches a maximum as the level of the mercury column gradually

falls, when, quite suddenly, its motion becomes markedly less. At the moment of this reduced movement the level of the mercury will indicate the diastolic pressure.

Cautions.—To obtain accurate and reliable clinical data with the sphygmomanometer, it is important that some systematic technic be adhered to, and that all observations not only on the same patient, but in all cases, be made under as nearly the same conditions as possible. Attention to detail will eliminate largely the errors arising from such factors as position of the patient, presence of fatigue or mental excitement, arm used for observation, etc. It is also valuable to note the apparatus used, the time of day, the pulse rate, the sex and age of the patient.

It is important that the location of the cuff should be at the heart level, otherwise the reading will be affected by the weight of gravity on a column of blood, being higher or lower, according to whether the cuff is above or below the heart level. The further the cuff is below the heart level the higher the reading.

Position of Patient.—From the studies of Sandford and others, as recorded on page 55, it will be seen that the position of the patient is of great importance, as the systolic pressure under the same conditions rises from 5 to 15 mm., as the posture of the patient chances from the standing to the recumbent posture.

Continued constriction of the arm by the cuff for more than a minute or two will provoke vaso-motor changes in the member, which may cause a rise of from 5 to 10 mm. in subsequent readings.

Another point of importance in connection with the

actual use of the blood-pressure apparatus is that when taking the systolic pressure *the reading should never be made as the pressure is being raised in the cuff, but only* after the obstruction of the vessel is complete by the air in the cuff and *while the column is returning* by means of the escape of air through the valve. Experience has shown that there is a difference of several millimeters between readings made in these two ways, and that the reading taken at the moment of the return of the first impulse at the wrist is the true systolic pressure.

No single reading should be accepted when it is possible to make more than one. It is better to see the patient a number of times under varying conditions before deciding what his blood-pressure is.

The following **printed record form** has been taken from the Author's Work on Essentials of Laboratory Diagnosis, 4th edition, F. A. Davis Co., Philadelphia, 1912. This will be found useful for keeping a complete record of the Blood-pressure Test, also the chart as shown in Fig. 19 (page 51) is valuable where a series of observations are made upon one patient. This chart is arranged to keep the readings in graphic form, similar to the usual temperature chart.

Some observers prefer the graphic charts which show the variation in blood-pressure and pulse in the same manner as a temperature chart.

The accompanying cut shows a chart which has been carefully prepared and which is arranged to show both systolic and diastolic pressure, together with pulse rate, in such a manner that they do not become superposed. These may be obtained on the market in pads of 25 for a nominal figure or directly by writing to G. P. Pilling & Son Co., Philadelphia.

BLOOD-PRESSURE DETERMINATIONS

CLINICAL REPORT

.....

.....

Apparatus {

Width of Cuff cm.
Part examined,
Right,
Left,
Posture,
Pulse Rate,
Systolic mm. Hg. after 10 bending movements, mm. Hg.
Diastolic mm. Hg. after 10 bending movements, mm. Hg.
Pulse Pressure mm. Hg. after 10 bending movements, mm. Hg.
Mean Pressure mm. Hg. after 10 bending movements, mm. Hg.

Remarks.

Time of Day, A. M.....P. M.....

Date.....

Examined by .....

FAUGHT CHART FOR BLOOD-PRESSURE RECORDS.

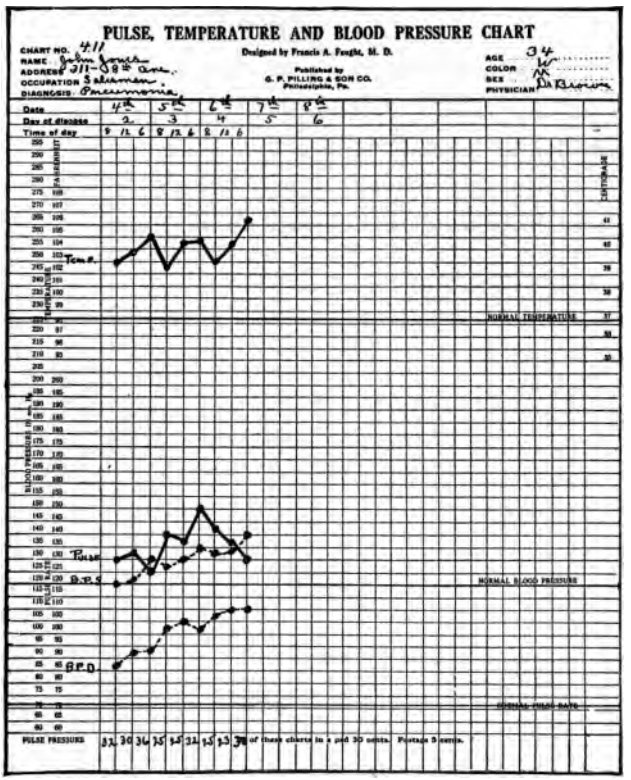


FIG. 19.—Blood-pressure recording chart, about one-eighth actual size. Designed to record systolic pressure, diastolic pressure, pulse rate and temperature.

Published by G. P. Pilling & Son Co., Phila., Pa.

CHAPTER IV.

NORMAL BLOOD-PRESSURE AND ITS VARIATIONS.

CHAPTER IV.

NORMAL BLOOD-PRESSURE AND THE CAUSES OF VARIATION.

When **normal blood-pressure** is spoken of in discussion, it is accepted to mean that the pressure in each individual case is within the recognized normal limits determined by clinical experience. This is not and cannot be a fixed pressure, as the normal temperature is a fixed degree. This is because blood-pressure at any given moment is the result of a combination of variable factors, which must unite to determine it, and because it has been found by experience that blood-pressure is regularly influenced and modified by the age and sex of the individual.

There are several methods of arriving at an estimation of the normal pressure and its variations in a given case. Thus we can adhere to a table based on a large clinical and experimental study. Such a table, which conforms to the accepted standard, has been compiled by Woley.

Method of Estimating Normal Average.—The normal average systolic pressure can be readily determined for all ages by employing a formula devised by the author several years ago. This is based on the experimental study of many observers, and is designed to

estimate the age factor thus: "Consider the normal systolic blood-pressure of a healthy adult male, age 20, to be 120 mm. Hg. Then for any two years of life over this add 1 mm. Hg. to 120. Thus at age 30 blood-pressure equals 125, at age 60 it equals 140, etc."

The SEX FACTOR can be roughly reckoned as minus 10, so that all pressures as computed by this formula should have 10 mm. subtracted when estimating the average normal pressure for women.

It is accepted that other factors which are usually part of the daily life of an individual will somewhat influence the blood-pressure; thus:

PHYSICALLY WEAK persons will usually show a slightly lower pressure, often 5 to 10 mm., while the MUSCULARLY DEVELOPED will have a slightly higher average, about 5 to 10 mm.

The pressure after EXERCISE will be found from 10 to 20 mm. above the average, but will rapidly return to normal. The same may be said of the first hour after a hearty meal.

Effects of sleep and rest on Blood-pressure.—Brooks and Corroll (Arch. of Int. Med., August, 1912) studied this effect in 68 patients, showing average systolic pressures in 30 with low pressure and 20 with abnormally high pressure. The results in the general way are illustrated in the cases with average pressure. Readings were taken from 1 to 2 hours after the beginning of sleep and showed an average fall of 24 mm.; three hours after waking in the morning there was still an average depression of 12 mm. In these persons the pressure gradually rose to its high level in the afternoon.

The greatest nocturnal fall in pressure took place in cases having the highest initial systolic pressure. Disturbance of the patients during the first sleep delays, but does not necessarily prevent the fall. Frequent interruption, however, does prevent it.

The use of hypnotic doses of drugs to produce sleep, as 120 grains of bromide of potassium or chloral hydrate up to 50 grains each night, did not increase the degree or persistence of the fall. Physical rest in general did not appear to alter materially either the subnormal or normal blood-pressure, but the authors were led to believe that mental and physic rest might cause profound changes in pressure and that these factors largely determine the undoubted benefit derived from rest in cases of high pressure.

Posture will affect the reading, and its effect is largely, if not entirely, due to the effect of gravity and the relation of the arm-band to the chief volume of blood in the body.

The effect of change of posture without active muscular exertion on arterial pressure was reported by J. H. Barach and W. L. Marks in *Archives of Internal Medicine,* May, 1913.

Without going into the methods employed in obtaining these conclusions, it is sufficient to say that the mercurial type of instrument was used with a 10 cm. cuff, that the methods were carefully checked by controls and that any outside factors which might influence the results were eliminated, as far as possible, and that all readings were repeated in order to eliminate accidental error.

The summary of results is as follows:

1. When the element of muscular effort has been eliminated, change of bodily posture from the erect to the horizontal will cause an increase in the maximum pressure, a decrease in the minimum pressure and an increase in the pulse pressure.

2. After five minutes in the horizontal posture, when the subject is returned to the erect posture, the maximum pressure will diminish, the minimum pressure increase and the pulse pressure diminish. It will be noted that in both instances the pulse pressure follows the same trend as the maximum pressure.

3. Change of posture from the erect to horizontal caused a fall in the venous pressure.

4. Change of posture from the horizontal to erect caused an increase of the venous pressure.

It will be noted that the venous pressure follows the same trend as the minimum pressure.

Nearly all subjects of this series responded in the same way. The most notable exception was in the "Poor Muscular Cases." These cases showed a tendency to a reversal of the pressure curve. Form erect to horizontal caused, in more than half of the cases, a decrease of the maximum pressure and an increase of minimum pressure.

GENERAL SUMMARY.

	Erect	Horizontal	Erect
Maximum	+	+	−
Minimum	+	−	+
Pulse pressure	+	+	−
Venous pressure	+	−	+

Time of day has a modifying influence on blood-pressure, being usually lowest during the early hours of profound sleep, rising slightly toward morning, and rising more or less rapidly, depending on the mental and physical activities of the individual, as the day advances. This variation may reach as much as 40 mm. Hg.

Ingestion of large amounts of fluid, particularly if ALCOHOLIC, will cause a moderate and brief rise.

Pain and anxiety are often a cause for a sharp and short rise.

Age.—The following table is taken from L. Gordon, who has made extensive study of the relation of age in normal children to blood-pressure.

	mm.
Under one year	71
One year	73
Two years	79.3
Three years	81
Four years	83
Five years	86.5
Six years	88.5
Seven years	85.0
Eight years	93
Nine years	100
Ten years	95
Eleven years	104
Twelve years	105

Effects of Altitude and Atmospheric Changes on Blood-Pressure and Pulse Rate.—Hoobler and Pomeroy, in a review of literature combined with their own observations on the effect of BAROMETRIC PRESSURE on blood-pressure, state that "the result of nearly all

experimental data shows that diminished barometric pressure lowers blood-pressure." C. F. Gardner has shown that a person going from an elevation of 6000 feet to one of 14,000 feet suffers a fall in blood-pressure and a rise in pulse rate. The results of Schneider and Hedblom are the same. They state also that the diastolic pressure tends to be lower by reduction in barometric pressure. That the fall in systolic pressure was slightly greater and more certain to occur than the fall in diastolic pressure. This effect becomes less marked as the subject becomes accustomed to the change. The change usually amounts to from 3 to 10 mm.; occasionally as much as a 20 mm. rise has been noticed.

In tuberculous subjects with hypotension, high altitude (6000 feet) causes a rise in pressure (Peters, *Arch. of Int. Med.*, Aug., 1908).

Colis and Pembrey have studied the important factors of RELATIVE HUMIDITY in the atmosphere to blood-pressure, and have found, by studies made in England, that when the ACTUAL HUMIDITY was greatly increased, a rise in pulse rate of 30 or more beats per minute not infrequently occurred, and there was also an increase in respiratory rate of from 18 to 29. The same results were noted when the actual humidity was increased.

P. P. Aminet examined a large number of healthy children of from 7 to 15 years of age in an effort to determine the effect of outdoor life on pulse and blood-pressure. He found that almost uniformly there was an increase in blood-pressure and in pulse rate. The pressure elevation amounted to as much with some cases as at 30 mm. Hg. Children living in

good surroundings have a generally higher blood-pressure than those in poorer environments. The same condition was noted by Hoobler in children suffering from tuberculosis or pneumonia.

Starling has studied the *effect of wind-pressure* upon the systolic blood-pressure, which has a very important bearing upon the effect of this condition upon cardiac cases. He found that wind-pressure has a profound influence in raising pulse rate. The same may be said of the effect of wind-pressure upon the blood-pressure.

Eating.—The blood-pressure normally rises from 10 to 15 mm. shortly after an ordinary meal, gradually falling toward the original level after an hour or more. The size of the meal is thought by some observers to affect the degree of elevation, being greatest after heavy meals which contain much proteid.

It is well recognized that certain changes in the circulatory system originate from disturbances in the digestive tract. These are usually seen in a slight increase in blood-pressure, due to the reflex from the splanchnic area affecting the muscular walls of the arteries. This may be considered normal to a certain degree, but it becomes pathologic where we find this elevation to be excessive and prolonged.

Alimentary hypertension is the result, therefore, of a normal abdomino-arterial reflex, made excessive by an over-abundance of food or an incomplete elimination of toxic substances. This continued hypertension is often the first link in the chain leading to arteriosclerosis, contracted kidneys and apoplexy.

Drinking.—Excessive ingestion of water causes a brief rise of blood-pressure, amounting to about 5 to

10 mm., although the habitual use of ordinary amounts need hardly be considered in any blood-pressure estimation. Large amounts of beer may be the cause of a sharp rise, which, when repeatedly recurring, as in habitual beer drinkers, may become the cause of a permanent hypertension, which may finally result in arteriosclerosis and chronic nephritis. Strong alcoholic drinks cause a primary rise from heart stimulation, followed by a secondary fall when vasodilatation occurs.

Smoking.—Smoking usually causes an elevation in blood-pressure, with the apparent paradox that many habitual smokers have a subnormal blood-pressure. The usual effect of one or two cigars, or its equivalent in other forms, in those accustomed to the use of the drug is a sedative action and a slight lowering of blood-pressure, while excessive smoking, during a short period of time, causes a rise of from 5 to 25 mm.

Bruce Miller and Hooker, after extensive study, arrive at the conclusion that smoking is an etiologic factor in arteriosclerosis, at least in so far as the effect of circulating toxic substances affect the enlargment of the vessel walls.

Permissible Variations.—From the foregoing it would seem that any study of blood-pressure must have its value greatly reduced by so many modifying factors, but careful thought will show that these at most cause only slight variation, which need not obscure the issue. Experience will teach the observer to unconsciously include these factors in practice and enable him to arrive at the correct value of his findings by aid of them.

DETERMINATION OF PATHOLOGIC BLOOD-PRESSURE

Abnormal blood-pressure may be either above or below the normal level, as compared to the normal average pressure and its variations. Blood-pressure should only be designated abnormal after careful study and repeated tests, unless the change is so marked as to be beyond question.

A single reading slightly above or below the normal boundaries may be occasioned by some accidental or peculiar incident, and should therefore not be taken too seriously and should never be assigned to an important role in diagnosis until its persistence has been demonstrated on at least two occasions.

Neither should one expect to find the same pressure, in any case, at all times. Never lose sight of the possible causes of normal variation. These normal variations may occur in a very short space of time, and should not, as in at least one instance known to the author, condemn the instrument, showing such variation, as inaccurate. Remember also that your unfamiliarity with a new type of instrument may cause you to neglect some detail which will invalidate your results.

Study your instrument, read your instructions and be sure of our technic.

Arterial Hypertension.—For a proper understanding of the treatment of the various conditions associated with which the arterial pressure is above normal, it must primarily be recognized that if the pressure is high there must be some underlying cause for the abnormality. Such cases can, as a rule, be divided into

three groups: mechanical, nervous and toxic. The most common mechanical cause is arteriosclerosis, and yet there may be pipe-stem arteries with normal pressure. The reflex nerve irritation of a peritonitis or a fright may cause a sharp rise in pulse tension, but in shock the blood-pressure falls. The cause of hypertension, which is probably the most widespread and the most frequent, is intoxication. It is generally considered that it is the irritation from poisons retained by the kidneys and not the mechanical obstruction, which sends the blood-pressure up in nephritis.

Continuous high pressure is seen in certain forms of NEPHRITIS. Thus, in primary acute Bright's disease and in nephritis secondary to scarlet fever there is practically always a marked rise in arterial pressure. A rise amounting to more than 50 mm. Hg. has been observed within 48 hours of the onset of an acute nephritis. Elevated pressure is also found in beginning ARTERIOSCLEROSIS of the first part of the aorta and of the splanchnic vessels.

In dealing with the elevation of pressure, which is the result of the action of drugs or of toxic agents, it is important to bear in mind that the amount of the substance and its concentration, its potency as well as the duration of its action will determine the amount of elevation, the duration and the permanence of the effect.

Arterial Hypotension.—This term is applied to cases presenting a more or less continuous blood-pressure below the normal estimated pressure. A pathologic depression in blood-pressure may be caused by the depressing influence of CIRCULATING TOXINS acting

either upon the heart blood-vessels or controlling nervous mechanism or to sudden withdrawal of a large volume of blood from the circulation, as in HEMORRHAGE, after venesection, copious diaphoresis, diarrhea, or in shock.

The lowest blood-pressure compatible with life has been reported by Neu to be from 40 to 45 millimeters of mercury, and this only occurred with subnormal temperature in the moribund state. He has seen recovery after a fall in pressure as low as 50 millimeters.

In general, it may be said that lowered blood-pressure is of little significance except after hemorrhage or during surgical shock. Here the great and sudden reduction in pressure may be sufficient to immediately endanger life.

It is noted that a moderate and progressive fall in pressure occurs in most progressive and prolonged fevers, as in typhoid fever. When due to such a cause, the depression is rapidly overcome and disappears as convalescence is established.

Widespread dilatation of the vessels and consequent lowering of blood-pressure has been noted in the last stages of ARTERIOSCLEROSIS.

Arterial dilatation and lowering of blood-pressure may result from general loss of arterial tone. Thus, if the splanchnic vessels become widely dilated and filled with blood, the other arteries are insufficiently filled (there is insufficient blood in the body to properly fill the arteries if they are all widely dilated) (see page 85), and the pulse becomes soft, the temperature falls and syncope finally ensues.

CHAPTER V.

PRACTICAL APPLICATION OF CLINICAL DATA.

I

CONDITIONS ACCOMPANIED BY HIGH PRESSURE.

II

CONDITIONS ACCOMPANIED BY BUT SLIGHT PRESSURE CHANGE.

III

CONDITIONS ACCOMPANIED BY LOW PRESSURE.

I

II

III

CHAPTER V.

PRACTICAL APPLICATION OF CLINICAL DATA IN EVERY-DAY PRACTICE.

As already stated, the relation of blood-pressure in disease, compared to the estimated normal in health, may be variable (slightly above or below), may tend to hypotension or may show high pressure. The arrangement of the various conditions treated in the following pages is entirely arbitrary, being based on a plan which renders the material most readily accessible and easily obtainable for immediate reference.

High Blood-Pressure Is a Symptom, Not a Disease.—It is present in a number of common pathologic conditions, and when found, aids greatly in explaining certain phenomena connected with the heart, blood-vessels and kidneys. The state of the blood-pressure often furnishes the one important clue which leads to correct diagnosis or directs the attention to an altogether unsuspected complication.

For example, a case of pneumonia is related in which all was progressing satisfactorily until one day the patient did not seem to be as well as the state of his disease would warrant. A blood-pressure test, made by a consultant who had been called, demonstrated an abnormally high blood-pressure. The urine was then examined and evidence sufficient to establish the presence of a complicating nephritis was found.

At the present time certain diseased conditions are well recognized as being productive of or usually accompanied by an elevation in blood-pressure. The two almost classical high blood-pressure conditions are arteriosclerosis and acute and chronic nephritis. Other conditions in which a high pressure is often found are chronic myocarditis, the complications of arteriosclerosis, as angina pectoris and apoplexy. Also uremia, the toxemia of pregnancy, lead poisoning, peritonitis and cerebrospinal meningitis.

CONDITIONS IN WHICH HIGH BLOOD-PRESSURE IS A PROMINENT SYMPTOM.

Arteriosclerosis, as the term is here employed, implies a condition of generalized chronic hyperplastic involvement of the coats of the arteries. In this condition we find a permanently elevated blood-pressure, the degree of which is dependent upon the extent of the involvement present. The wider the extent and the greater rigidity of the vessels the higher will the systolic pressure be. This pressure may reach 300 mm. The average case will be found to run in the neighborhood of 200 mm. Owing to the lack of elasticity, the mechanics of the circulation are so deranged that the diastolic pressure will be found disproportionately low, with corresponding greater increase in pulse pressure. It is not uncommon to find a pulse pressure of 100 or more. The reduction in the ratio of pulse pressure to systolic pressure, under treatment, is a valuable sign. It must be remembered, however, as has been pointed out by Rudolph, that the blood-pressure in arteriosclerosis is not always

high, especially when the arterial involvement is localized, as in the superficial vessels, also that very high blood-pressure may be net as a result of arteriosclerosis, in the presence of apparently soft superficial vessels, when the larger trunks, such as the splanchnic area, is affected.

Sir Clifford Albutt divided the cases of high pressure related to arterial changes into three classes:

First—Hypertension cases.

Second—Those of toxic or infective origin.

Third—Involutionary or true sclerotic cases.

In the first class the elevated blood-pressure proceeds and produces the arterial change, while in the third the pressure is the direct result of the disease.

As a rule, the degree of elevation in pressure will indicate the extent of arteriosclerotic involvement. the presence of a complicating nephritis, myocarditis or an aortic regurgitation will tend to further elevate the blood-pressure. The terminal stage of a long-standing arteriosclerosis, even when complicated by other conditions causing high-blood pressure, is usually marked by a falling and finally a subnormal blood-pressure.

The blood-pressure test in cases of arteriosclerosis, besides being of great value in effecting the proper diagnosis, is also of marked assistance in following the effect of treatment and in forecasting the future. But of greater value even than the systolic pressure is the diastolic, which should be estimated in order to determine the pulse pressure, which is the truest indication of the amount and severity of heart overwork, which, after all, is the determining factor in the case.

Angina Pectoris.—This is usually a syndrome, developing in the course of a case of general arteriosclerosis, and denotes involvement of the coronary arteries in the arteriosclerotic process. The blood-pressure rises just before and remains high during the paroxysm of pain, usually subsiding shortly thereafter. The rise may amount to 50 mm., and there may be little or no elevation in blood-pressure during the interval. The reduction of high blood-pressure in those with a tendency to angina is often most successful in preventing subsequent attacks.

The blood-pressure test sometimes serves as a valuable aid in differentiating true angina from those conditions best termed anginoid, which are so often met and which frequently cause the physician much trouble and embarrassment in estimating their true significance. It is believed by Janeway and others that, given a case presenting the symptom complex of angina, in which the blood-pressure is continually abnormally high, it will probably be one of true angina; while unfortunately the converse is not true, as cases of demonstrated true angina have been met in which the pulse is small, easily compressible and the tension low.

Acute Nephritis.—A sharp rise in blood-pressure is usually the first sign of the onset of an acute nephritis. This complication, developing in the course of an acute infection, may be discovered by a routine study of the blood-pressure, where the rise may antedate the development of the usual signs, including alterations in the urine by as much as 24 hours. This fact should be a most emphatic indication of the value and importance of daily blood-pressure readings during the course of all infections, particularly scarlet fever.

Acute Nephritis in Children.—Lennox Gordon reports 9 cases, in all of which the blood-pressure was raised, in some cases to a very high level, and in them this was of very marked diagnostic value. He believes that by means of the sphygmomanometer only could the change in blood-pressure in children be ascertained to any degree of certainty.

Chronic Nephritis.—A gradually developing chronic nephritis is shown by a gradually rising blood-pressure, accompanied by the usual alterations found in the urine. A high blood-pressure reading, of more than 200 mm. found during the examination of any patient should place one on guard and start a careful examination for other signs of this condition.

The blood-pressure in chronic nephritis is persistently elevated, and may be extremely high. Pressures of over 300 mm. have been reported. A sudden further rise in pressure occurring during the course of a chronic nephritis is often a most valuable warning, as a sign indicative of an impending uremic attack. This rise, if noted early, furnishes the basis for immediate action, to control the pressure by powerful eliminative measures in order to avert, if possible, the uremic attack. Such treatment if often very successful.

J. Fischer, in the *Duch. Arch. f. klin. Med.*, 1913, after a study of 550 patients running a continuous high blood-pressure, emphasizes the importance of being on the lookout for permanent kidney lesions in patients even with a moderately high pressure, as in 62% of his series with pressure above 140 there were signs of permanent kidney lesions, while 80% had chronic kidney change, and in some of these there

was no clinical evidence of kidney trouble, excepting continuous high blood-pressure.

A study of blood-pressure in cases showing transient or persistent traces of albumen in the urine will often serve to demonstrate the cause and seriousness of this condition, because it is well known that high blood-pressure is always an accompaniment of chronic nephritis, and also because it is believed that a normal blood-pressure, even with albumen in the urine, places the albumen in a class with minor and not serious affections. Unexplained persistent high blood-pressure, even when albumen cannot be demonstrated in the urine, furnishes ample grounds for strongly suspecting chronic changes in the kidneys.

After a long or short period of sustained high pressure in chronic nephritis, the pressure will begin to fall, and after a long period of time fail to raise to its highest level. Experience teaches that this is a danger signal that the reserve of the heart and circulation has been exhausted and that a further fall may be expected, and that, sooner or later, this will result in retarded kidney activity and all that this implies.

Chronic Parenchymatous Nephritis.—The few available reports on blood-pressure in this disease fail to show that a high blood-pressure is an accompaniment of it or that the blood-pressure bears any relation to the duration or severity of the kidney inflammation.

Uremia.—This often fatal complication of nephritis is accompanied by a sudden and often sharp rise in an already greatly elevated blood-pressure, or else an already high pressure begins to mount upward to a dangerously high level. These changes in blood-pressure may, by careful observation with the sphygmo-

manometer, be noted sufficiently early to allow time for the institution of preventive measures, directed toward the relief of toxemia, by increasing elimination. The blood-pressure during an uremic attack may be far above 300 mm. Actually how high has not been recorded, because before the development of the Faught Clinical Sphygmomanometer no instrument was capable of recording pressures above 300 mm.

In patients who are seen in emergency and are found profoundly unconscious, the sphygmomanometer will often be the means of separating the coma of uremia with high blood-pressure from coma of other origin.

In Valvular Lesions.—In the study of the valvular disease of the heart the results do not seem to have special bearing upon the primary condition (defective valve) except in cases of aortic regurgitation. This is in part due to the usual complicated nature of the condition, which often includes arterial and myocardial changes and involvement of the kidneys.

The chief value of the sphygmomanometer in the study of heart conditions applies to the condition of the myocardium, to a demonstration of the effect of therapeutic measures and as a guide in prognosis and in the general management of cases. With it we are able to determine with considerable accuracy the benefit derived from the drugs and other measures employed. In this we may guard against insufficient or improper treatment and also against the over-use of these same measures by demonstrating the therapeutically efficient dose and the proper interval of its exhibition.

Aortic Regurgitation.—The blood-pressure test may be sufficient to establish a diagnosis in pure aortic regurgitation, the great pulse pressure occurring in this condition being almost pathognomonic. Referring to the physics of the circulation, we find that in aortic regurgitation the left venticle is called upon to deliver an abnormally large volume of blood into the aorta to supply the demands of the circulation. This is because the heart is required not only to furnish sufficient blood for the needs of the body, but must also inject into the aorta at each systole enough surplus to compensate for the regurgitation of a large volume of blood into the left ventricle during diastole. The natural result of the sudden injection of this large amount of blood into the arterial system will be to cause a sudden and great rise in systolic blood-pressure (immediately succeeding systole the blood disperses in two directions, forward through the capillaries and backward into the ventricle, producing the phenomenon of the water-hammer pulse). Thus the pressure rapidly falls and the diastolic pressure is abnormally low. THE COMBINED RESULT OF THIS HIGH SYSTOLIC AND LOW DIASTOLIC PRESSURE IS A GREAT PULSE PRESSURE. This may amount to 100 mm. or more.

In the presence of moderate or high-grade generalized arteriosclerosis, this phenomenon is further accentuated because the lack of normal elasticity in the arterial system tends to reduce the diastolic pressure to zero.

Occasionally, in cases of mitral stenosis, the blood-pressure may tend toward a low level, but this is

usually more than compensated for by the accompanying changes in the heart muscle and larger arteries.

Acute Endocarditis.—In a few cases of acute endocarditis that have been reported, it has been found that the endo-cardial condition itself has little, if any, effect on systolic blood-pressure.

Myorcardial Degeneration.—Many cases of chronic myocarditis have sufficiently marked signs to be easy of diagnosis; in other cases of the cardiovascular renal type diagnosis may be extremely difficult. Here it is most important that the general practitioner should be able to recognize these changes sufficiently early to be able to institute treatment with good chance of arresting the progress of the disease indefinitely or as long as the patient adheres to his new regime. These cases usually occur in middle life, and may be far advanced before discovered, as they often are, accidentally, in the course of examinations for life insurance. The difficulty of correctly estimating them is great, for, while we may be morally certain of the existence of heart weakness, we may not be able to prove the existence of myocarditis, and often erroneously class them as nervous or functional.

In the physical examination the state of the superficial vessels, together with the pulse rate and particularly the reaction of the heart to posture and exercise as determined by the sphygmomanometer, is all-important. This latter may be determined by the following tests:

Functional Tests.—Moderate exertion raises pressure in normal hearts, and this rise is sustained during it if not unduly severe or prolonged. In weakened heart muscles from any cause a primary rise may

occur, but is quickly followed by a fall; in the worst a fall occurs from the first.

Schapiro's Test.—This is based upon the alteration in pulse rate occurring in normal individuals on change of posture from the standing to the recumbent. Normally the number of pulse beats per minute is from 7 to 10 less in the recumbent position; but when chronic myocarditis develops, this difference tends to disappear, so that in seriously weakened hearts the pulse may be as rapid in the recumbent as in the sitting posture.

Graupner's Test.—This is based upon the physiologic fact that a given amount of exercise, such as ten bending movements or running up a flight of stairs, causes an acceleration in the pulse rate and an elevation in blood-pressure. But the latter does not appear coincidently with the former; or if, as in some cases, the pressure does rise first, it fails to rise again after the pulse has returned to normal. It is this secondary rise which indicates a good heart muscle. A not too seriously affected heart may show a rise in blood-pressure immediately after the exertion, but with the slowing of the pulse the pressure will be found to have fallen to a level lower than before the experiment. The sphygmomanometer is required for an accurate demonstration of these changes in pressure, which may be recorded in definite units of measure for future reference and comparison.

IT IS NOT ADVISABLE TO APPLY THIS TEST TO PATIENTS WITH EXCESSIVELY HIGH BLOOD-PRESSURE, IN THOSE OF APOPLECTIC TENDENCY OR IN THOSE WITH HIGH-GRADE ARTERIOSCLEROSIS. The test is unsafe in those with a systolic pressure of 200 millimeters or

over. In such cases there is danger of ocular or cerebral hemorrhage or acute dilatation of heart.

The test will be difficult, if not impossible, of application in women unless all tight clothing is removed.

Valvular disease is not necessarily a contraindication to this test, as the condition of the myocardium seems to be the only important factor, except in aortic regurgitation with high pressure, so that the presence of valvular lesions need not detract from the value of the information obtained by this test.

The Effect of Altitude on Cardiac Cases.—It is important to consider the condition of the patient in reference to the circulation before advocating residence in high altitudes. In young convalescents, in the absence of organic heart affections, even in the presence of the moycardial weakness due to recent acute or chronic infections, moderately high altitudes are usually beneficial.

In the arteriosclerotic without valvular lesions, the cardiac reserve is often much exhausted, and therefore sudden changes in altitude may result in serious consequences through added sudden strain on the circulation, due to changes in peripheral resistance. High altitudes may be extremely dangerous. In the true cardiac case with organic lesion, high altitudes are often dangerous because, even when compensation is fairly well established, the balance in favor of the heart is very slight, and here again the changes in circulatory equilibrium, by causing slight increased strain, may again produce decompensation.

Eclampsia.—Blood-pressure is usually high, but may occasionally, in very severe cases, be low. Pressures have been recorded as being over 320 mm. See also page 92.

Cerebral Hemorrhage.—The occurrence of a cerebral hemorrhage is usually preceded by a long period of high blood-pressure, accompanying a nephritis, an arteriosclerosis, or both. It is not the degree of permanent elevation so much as a sudden rise in an already high blood-pressure that causes the vessel to rupture.

Thus cases of arteriosclerosis, showing an average systolic blood-pressure of 225 mm., have, following a rise of 30 or 40 mm. more, suffered an apoplexy. On the other hand, the author has seen more than one case of chronic nephritis registering pressures frequently above 250 mm., occasionally over 300—one case almost 310—without the occurrence of anything more serious than a mild cerebral edema of very transitory character. The highest blood-pressure readings occur in apoplexy cerebral thrombosis, depressed fracture, intracranial hemorrhage and in rapid growing cerebral tumors. Pressure up to 400 mm. has been recorded in these cases, while the diastolic pressure is extremely low and the pulse rate slow. The value of this high pressure in these conditions is probably directed toward maintaining a fair blood supply against the greatly increased intracranial tension. This emphasizes the importance of recent teaching that one should not bleed or make other effort to lower the pressure in these cases, but to operate immediately or else administer atropine in large doses to keep the pressure up, and await developments.

Migrain.—Migrain is usually accompanied by hypertension, which may, according to Russell, be localized and confined to the arteries upon one side of the body, particularly those of the head. The discovery of

hypertension in any case, the subject of periodic attacks of hemicrania, will furnish reasonable ground for therapeutic endeavors, as it has been shown that the reduction of hypertension by eliminative measures in these cases is often successful in preventing, or at least reducing, the severity of the attacks.

Chronic Lead Poisoning.—Chronic lead poisoning, accompanied by attacks of colic, is usually attended with an increase in blood-pressure. Temporary elevations of 30 or 40 mm. have been recorded. The fact may be of value in differentiating colic due to lead from renal and biliary colic in which the blood-pressure is low.

Eye Diseases.—It has long been recognized that high blood-pressure is an important factor in several eye conditions, but not until recently has this knowledge been put to practical clinical use by the ophthalmic surgeon.

Arteriosclerotic changes in the retinal vessels will immediately suggest the necessity of a blood-pressure test. The finding with the sphygmomanometer will reveal the significance of the eye condition by demonstrating the degree of general arteriosclerosis present. This knowledge may be put to practical use by instituting measures directed toward relieving the high pressure and by modifying the individual's life and habits in an effort to arrest the arteriosclerotic process.

Ocular Hemorrhage.—Fox and Batroff report in detail a study of one hundred consecutive cases of ocular hemorrhage in which the blood-pressure test was employed. In 80 per cent. of these cases hypertension was encountered. 40 per cent of the cases of retinal hemorrhage were accompanied by chronic inter-

stitial nephritis. Arteriosclerosis was present also in 27 per cent. and parenchymatous nephritis in 13 per cent.

Asphyxia.—The effect on the cerebral centers in this condition, no matter what its cause, is usually a marked rise in blood-pressure. This is seen in nitrous-oxide anesthesia. The condition is also met in asphyxia and cyanosis from other causes, such as obstruction to the larynx, diseases of lungs, etc.

Syphilis of the Heart and Blood-Vessels.—The usual diagnosis of syphilis of the heart and blood-vessels must be based on the same grounds which serve us in diagnosing other syphilitic manifestations.

As the syphilitic heart and blood-vessels show clinically nothing absolutely characteristic, nothing which is not found in other diseases, we should be suspicious of syphilis in any patient with arterial involvement before judging it to be senile arteriosclerosis, especially when the process includes the aortic valves and when incompency develops gradually rather than suddenly, and when it is not accompanied by fever or other signs of acute endarteritis.

The Wasserman and Leutin tests will show syphilis to be present much more often in such diseases than is usually believed. The relative rise in pressure will, of course, depend largely upon the extent of the involvement or whether or not the arterial tree is included in the process.

DISEASES IN WHICH THE BLOOD-PRESSURE IS NOT GREATLY AFFECTED, BUT IN WHICH INFORMATION OBTAINED BY THE SPHYGMOMANOMETER IS OF VALUE.

In **asthma** the value of the blood-pressure reading will depend upon the variety of this disease encountered.

In cardiac asthma the pressure is, as a rule, low. The finding of low blood-pressure accompanying a case of cardiac asthma is an indication for support of the heart and circulation; improved heart tone and a better circulatory equilibrium being followed by a lessening in frequency and lengthening of the interval between attacks.

In asthmatic attacks of other origin the blood-pressure is variable, and unless markedly altered from the normal, is of little significance.

Chronic Bronchitis.—The general condition of the patient will influence the blood-pressure finding. The occurrence of hypotension in chronic bronchitis will suggest the advisability of tonic measures directed toward improving cardiac and blood-vessel tone.

Neuralgia.—This condition is usually accompanied by a reduction in pressure, although this may not be sufficient in degree to be noticeable. This lowering of blood-pressure is in all probability due to the influence of pain upon the vasomotor system.

Neurasthenia is believed to be accompanied by a hypotension. This appears to be apart of the general loss of tone present in this disease and may be a rough indication of the severity of the exhaustion state.

It is well known that, in active men who are approaching middle life, the insidious development of arteriosclerosis or chronic nephritis, or both, frequently shows itself in a symptom-complex comprising irritability, lack of concentration, a feeling of lost confidence in one's self, sleeplessness, general fatigue, etc., a combination of symptoms often occurring in true neurasthenia. In these cases a study of blood-pressure is most important as a guide to diagnosis, a heightened blood-pressure often being the one sign by which the true diagnosis is reached.

Obesity.—Obesity *per se* has no modifying influence on blood-pressure. The relative level of blood-pressure found in any case of obesity does not depend on the size of the arm to which the cuff is applied, and will be normal for the age of the individual examined, unless the excessive fatness is in the relation of cause or effect with some anatomic or pathologic change, in the heart, blood-vessels or kidneys.

The disturbing effect of edema in cases of obesity should be remembered, as the presence of edema in the arm to which the cuff is applied when taking blood-pressure will so interfere with the transmission of pressure as to render the observation valueless.

In **insanity** (mania), the mental state of the case at the time of examination will largely determine the pressure level, which, if not normal, may be either slightly above or below it. The characteristic effect of blood-pressure altering complications will be shown here as in normal individuals, and here, as in any case, blood-pressure records are valuable, in that they may early detect the onset of complicating affections and may aid the defendant in his efforts to prevent their development.

Rheumatism has been singled out from the many acute infections as a condition for special blood-pressure study. The result of these studies simply shows that rheumatism, like any other acute infection, is accompanied by an elevation in pressure (10 to 20 mm.) during the period of invasion, that in severe cases it may fall to a marked hypotension and that convalescence is marked by a gradual return to normal unless influenced by the development of complications.

Exopthalmic Goiter.—The involvement of the cardiac and vasomotor centres in this disease has been shown to be accompanied by an irregular effect upon the blood-pressure, the stage of the disease and the severity of the symptoms determining the result. Thus some observers have reported an upward tendency and some a downward. The study of blood-pressure may be of value in this disease, by showing the relation of a tachycardia to a hypotension, thus directing the treatment upon more rational lines.

The **cessation** of **menstruation** at the climacteric, while physiologic in nature, is more often than not pathologic in character, particularly that part of the phenomenon involving the nervous system. In this state, as in all profound nervous disturbances where the cardiac and vasomotor activities are involved, we have more or less frequent disturbances of vasomotor character, as shown by palpitation, tachycardia and flushings. These are often accompanied by alterations in blood-pressure, whose chief characteristic is a sudden variation in the pressure curve from normal to hypo- or hypertension and back again.

Infectious Diseases.—In diphtheria, scarlet fever and infectious diseases in general the blood-pressure shows some variation, which is mainly dependent upon the period of the disease. Thus it is found that pressure has a tendency to rise slightly (5 to 15 mm.) during the period of invasion, and then to fall gradually during the further progress of the disease to a hypotension, to rise again toward normal as convalescence is established. The occurrence of complications will be shown by a change in blood-pressure which fails to conform to this rule. Thus a complicating nephritis will be shown by an early and sharp rise in blood-pressure. This may measure more than 50 mm. in twenty-four hours.

Typhoid Fever.—A slight primary rise may be noted, but this is a disease of low blood-pressure, in which the readings are not infrequently all below 100 mm. A markedly depressed blood-pressure during the attack is a valuable indication for the need of stimulating treatment. A fall in pressure occurring suddenly, especially after the second week, is usually indicative of hemorrhage. A short, sharp rise is often a valuable sign, pointing to perforation or peritonitis from a deep ulcer.

Pneumonia.—Gundrum and Johnson (*California State Journal of Medicine,* Vol. 10) report studies of a series of thirty cases of pneumonia in which the blood pressure and pulse rate were taken simultaneously. Twenty-six were lobar pneumonia. The patients were all adult males, 20 were alcoholics. The mortality was 30%.

The blood-pressures on admission show a great variation, ranging from 65 to 122 mm., while the

pulse ranged from 68 to 148. According to Gibson's rule on admission, 18 patients were in good condition and 12 in poor. Of the 18, 17 recovered (94%) and one died (6%). Of the 12 patients in poor condition, 3 recovered (25%) and 9 died (75%).

This study emphasized most powerfully the accuracy of the observations made by Gibson several years ago, and make it imperative that every physician should routinely employ the blood-pressure test in all cases of pneumonia, not only to effect a better prognosis, but to guard against the development of danger symptoms.

Injections of Salvarsan and Neo-Salvarsan.—During the intravenous injections of these substances collapse not infrequently occurs without a moment's warning. It has been suggested by some observers that frequent, rapid blood-pressure tests made during this procedure would be a valuable guide as to the safe progress of the operation, and also that this test may be used as a guide to the amount and rapidity with which the drugs may be administered.

Epilepsy.—Owing to the increased muscular activity occurring during an attack of apoplexy, the blood-pressure shows a rapid rise during the violent stage, and a rapid fall usually to the point of original level, as the paroxysm subsides and coma develops. In a patient seen during coma, where the patient's history cannot be obtained, this fact may be of aid in differentiating the coma of epilepsy from that caused by uremia or apoplexy, in which high pressure is the rule.

PATHOLOGIC CONDITIONS IN WHICH THE BLOOD-PRESSURE IS USUALLY BELOW NORMAL.

In discussing low blood-pressure we must classify several varieties of this condition in order to appreciate the underlying factors leading up to and resulting from this condition. They are as follows:—

Terminal hypotension means the gradual lowering of blood-pressure which occurs during the last hours or days of life, and is the direct result of a gradually failing cardiovascular mechanism.

Essential hypotension is met in cases in which the cause of the low pressure cannot be explained. Found occasionally in members of tuberculous families, in whom no definite signs of the disease are shown. It is a particularly common condition in those cases which are now occasionally recognized as having congenitally small hearts and narrow arteries.

Primary or True Hypotension is defined by Bishop as being present in those cases where the blood-pressure mechanism has failed, but where there has been no previous over-demand for pressure.

The term **Relative Hypotension** is applied to the condition of blood-pressure occurring in individuals who have had a distinctively permanent elevation in blood-pressure, but in whom the pressure at the time of examination is found to be normal or slightly above. These cases are most significant, as it is in them that we meet most serious and distressing symptoms pointing to circulatory failure, yet in whom the pressure is still above the estimated normal level. This relative hypotension is sometimes hard to establish, but if once determined and satisfactorily ex-

plained the knowledge furnishes a basis for rational treatment.

Diabetes.—The blood-pressure in diabetes is low, often being found below 100 mm. The chief value of the blood-pressure test in this disease is in the detection of complications involving the kidneys. A rising blood-pressure found in the course of a case of diabetes will direct the attendant's attention to the kidneys, when a urinalysis will often explain the origin of the "turn for the worse."

Cardiac Dilatation.—As would be expected, dilatation of the heart is accompanied by a dangerously low blood-pressure, which may be sufficiently low to endanger life. The finding of a low pressure in a cardiac case will plainly indicate treatment directed toward preventing syncope.

Improvement in the condition of caridac contraction will be shown by a gradually rising pressure, accompanied by a falling pulse rate and an increase in the pulse pressure.

Shock and Collapse.—These are two complications which may develop under a variety of circumstances in many disease conditions. In many cases which are in an apparently good condition, the sudden development of one of these complications may result fatally. It becomes, therefore, of great importance to anticipate the onset of these complications and, upon noting the warning signs, to institute measures for their relief. This form of procedure is in many cases very successful. During surgical operations under anæsthesia the sphygmomanometer is of great service in detecting early circulatory failure from either heart failure or vasomotor paralysis. Many surgeons, among

them Bloodgood, of Baltimore, now employ the blood-pressure test in all operations, depending upon it for the continued safety of their patients. (See chapter on Surgery, page 95.)

Hemorrhage.—Closely allied to the preceding, at least in the seriousness and suddenness of its development, is hemorrhage, either external or internal. Following external hemorrhage, the blood-pressure will be found below normal, and the amount of this lowering will, in a rough way, indicate the amount of blood lost. This fact is true only when the observations immediately succeed the bleeding. The circulation very rapidly regains its normal equilibrium, so that after hemorrhage of 300 to 400 c.c., causing a reduction of 30 to 40 mm., it is soon overcome and the effect as demonstrated by the sphygmomanometer lost.

In those diseases in which **internal hemorrhage** is a complication, and after surgical operations where there is danger of secondary hemorrhage, the frequent employment of the sphygmomanometer is of greatest value in detecting this complication long before the patient is exsanguinated or in a dangerous condition.

To be of greatest value in detecting hemorrhage, the blood-pressure test should be made as often as the pulse and temperature is taken, and should be recorded on the combined chart which is made for this purpose (see page 32). Used in this manner, a rising pulse rate and a falling blood-pressure, even when the change is slight, will direct examination along such lines as will prove or disprove the suspicion.

Cerebral Embolism.—From the differential diagnostic standpoint, in cases where the decision rests between cerebral hemorrhage and embolism, the blood-pressure test is of greatest value, as it is well recognized that the pressure in apoplexy is always high, often above 300, while in embolism the reverse is usually the case. When a previous history is unobtainable, this test may be the one deciding factor.

Jaundice.—Blood-pressure is usually low in cases of simple catarrhal jaundice. This is probably due to the effect of absorption of intestinal products of decomposition arising from interference in digestion. It may be said that in practically all mild toxemias, particularly of gastro-intestinal origin, the tendency of blood-pressure is downward, often remaining for some time between 100 and 110.

Pulmonary Tuberculosis is a disease of low pressure. The degree of lowering of pressure is a good index of the severity of the infection and the progress of the case toward recovery or otherwise. Good authority teaches that blood-pressure gradually and steadily falls in cases of progressive pulmonary tuberculosis; that it becomes stationary and tends to rise as the disease becomes arrested, and that a rising pressure means a good prognosis, as the blood-pressure practically never returns to normal in unarrested cases.

The effect of high altitude on cases of pulmonary tuberculosis is to cause a rise in pressure; this rise being beneficial in that its effect is to increase the force and volume of the circulation.

Peters and Bullock (*Medical Record,* September 14th, 1912) sum up our knowledge of blood pressure in this disease, as follows:

1. Blood pressure is increased at elevations of 6,000 feet.

2. The pressure of consumptives is higher here than at sea level.

3. The pressure tends to increase with continued residence.

4. From a prognostic standpoint the blood pressure findings are of great value in tuberculosis.

5. There is no relation between the degree of involvement and blood pressure, but there is a constant relation between toxemia and blood pressure.

6. The pressure is increased with pulmonary hemorrhage.

Anemia, Chlorosis and Exhaustion States.—An impoverished blood and a reduced physical tone, affecting all organs and tissues of the body, results in loss of vasomotor and cardiac tone, which is easily demonstrated by the sphygmomanometer in varying degrees of hypotension. The chief value of these studies is in directing the physician's attention to the need of absolute recumbency and rest, in order to avoid syncope from a too greatly lowered blood-pressure.

Cholera.—The great loss of fluid in cholera results in such a depression in blood-pressure that measures to combat collapse are urgently demanded. It has been demonstrated that large amounts of saline introduced either subintravenously or intravenously accomplish this rest most satisfactorily. During the transfusion the sphygmomanometer is the best guide to the effect of the procedure.

If **diarrhea** is profuse, it will result in a lowering of blood-pressure. Under ordinary conditions this fall will be insufficient to demand special treatment, but in

greatly debilitated persons, as typhoid cases after hemorrhage, the sphygmomanometer may be of great service in demonstrating a dangerously low pressure.

In **Alcoholic delirium,** vasomotor paralysis present, this usually causes a marked lowering of the systolic pressure, therefore employment of sedative measures or hot pack, which might further cause a lowering of pressure must be used with caution for fear of subsequent collapse.

Position for Observation, Patient in Bed.

CHAPTER VI.

PREGNANCY, TOXEMIA AND ECLAMPSIA,

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PREGNANCY, TOXEMIA AND ECLAMPSIA

The obstetrician of the present day must have constant recourse to the blood-pressure test if he would maintain the lead in his profession. The sphygmomanometer now ranks with urinalysis in the examination of pregnant women. In the blood-pressure test we have a most valuable means of detecting early toxemias, which often lead to the eclamptic state. The blood-pressure test is capable of early furnishing very definite indications of departures from normal metabolism in the pregnant women.

Early Sign of Toxemia.—John Cooke Hirst (*N. Y. M. J.*, June 11, 1910) states that the earliest and most constant sign of toxemia in the latter half of pregnancy is a high and constantly rising blood-pressure, and this symptom may precede albuminuria and all other constitutional signs of an impending eclamptic attack.

Examinations of normal non-pregnant women, showing no signs of heart or kidney lesions, gave an average systolic pressure with the Faught instrument of 112 mm. He then took the pressure of 100 normal pregnant women, these showing no signs of albumin or any sign of toxemia, and found the pressure to average 118. He found that these figures held good

up to approximately seven and a half months, after which date there was a gradual rise, so that in the middle of the last month of pregnancy a fairer average was 124 mm.; with subsidence of the uterus the pressure showed a slight fall. This coincides with the observations of H. C. Bailey (*S. G. and O.*, vol. xiii, No. 5, page 485), who made 1,136 systolic readings on 145 normally pregnant women in Bellevue Hospital. The average normal systolic pressure was 118 mm. He states that his readings varied greatly, but that the high limit was rarely passed. Twenty-eight per cent. showed a variation of from 25 to 30 mm. in the course of several days. The study of the nitrogen partition of the urine of these women showed no marked changes, so that this was of very little value. In conclusion, he says that changes of less than 30 mm. above the normal average 118 means very little from a practical standpoint, and that at the onset of labor the pressure usually rises during the first and second stages of 140 and 150 mm. taken between the pains. Again another most careful observer, Hubert J. Starling (*Lancet,* Sept. 10, 1910), reports a study of blood-pressure, covering a period of five years in pregnant women in whom the normal average was from 110 to 120 mm.

All these observers are most emphatic in their statement that routine blood-pressure observations should be made a part of the periodical examination of pregnant women and that with the development of suspicious signs and advance toward the end of the gestation, the intervals between the tests should be shortened, and that the test should not be omitted during the puerperium, as in this state women may develop serious toxemia and eclamptic attacks.

Dangerous Pressures.—Thus from the analysis of blood-pressure readings made by many observers we believe that a pressure of 150 must be taken as a danger limit, and that any pressure above this demands vigorous investigation and treatment.

T. M. Green (*Boston M. and S. J., April* 28, 1910) conveniently divides toxemia of pregnancy in three divisions:

First, moderate increase in blood-pressure.

Second, marked increase in blood-pressure.

Third, extreme increase in blood-pressure.

To these may be added the fourth which is suggested by Hirst and by Bailey, namely, ***fourth,*** extreme eclamptic condition in which the blood-pressure may be low.

In the first two, symptoms disappear and blood-pressure falls after delivery. In the third and fourth, blood-pressure continues abnormal and the disease usually progresses to a rapidly fatal termination.

The blood-pressure seems to bear definite relation to the type of case, and its frequent observation should be of great value both in prognosis and in treatment.

According to Hirst, the highest pressure reported by him in the toxemic case without eclampsia was 192 mm. The highest in eclampsia was 320 mm. How high he was unable to determine, because the mercury ran out of the top of the tube before the pulse was shut off.

CHAPTER VII.

BLOOD-PRESSURE IN SURGERY AND ANESTHESIA.

CHAPTER VII.

BLOOD-PRESSURE IN SURGERY AND ANESTHESIA DENTAL ANALGESIA

Importance of Routine Study.—Joseph C. Bloodgood (*International Journal of Surgery,* January, 1913) states that in St. Agnes' Hospital during the last two years blood-pressure records have been made a routine in connection with investigations of nitrous-oxide and oxygen anesthesia. From these observations he concludes that "I am confident from this experience that the blood-pressure apparatus is an instrument of precision which will be more helpful than anything yet devised to help the surgeon to accurately judge the condition of his patient and to act accordingly. The blood-pressure records serve to warn the surgeon of shock long before the pulse, respiration or any other clinical sign."

"In all of my cases the blood-pressure reading is taken in the ward the day before the operation, on the morning of the operation, when the patient reaches the operating room, before the anesthesia is administered and repeatedly during the operation. It is most important to note the blood-pressure after the anesthesia is off and before the patient is transported to the ward. When the blood-pressure is low (110 or less) the patient is not removed from the

table, but is kept in an adjoining room until the reaction is satisfactory. Collapse after their removal to their beds will thus be prevented."

This investigator has also observed that when, after painful manipulation, instead of a primary rise there is a fall in pressure, and when the blood-pressure does not rise again after the painful manipulation is discontinued, these must be looked upon as warnings of impending shock.

As an indication for venesection, saline infusion or the Murphy treatment, and as a guide to the beneficial effect of these several measures, the sphygmomanometer is pre-eminent.

Operations after Accidents.—The question of the safe outcome of any proposed operation frequently determines the question for or against operating on patients who have suffered accidents. This question really amounts to a determination of the degree of shock which the case has already suffered and an estimation of how much more shock the case is able to bear. This is best determined by the sphygmomanometer.

Bearing on this phase of the subject, Colcord (*International Journal of Surgery,* June, 1913) has contributed some valuable data on the effect of traumatism on blood-pressure. He noted that when there is injury to the spinal cord or epididymis, there is an immediate fall in blood-pressure. That severe injury to the thigh or hip-joint often has the same effect. Fractures of the base when accompanied by severe trauma, result in powerful inhibition of the heart and respiration, sometimes resulting in sudden death. The same inhibitory effect is noted in most any region supplied by the superior laryngeal nerve, and that operation

upon the larynx, pharynx and nasal chambers often show these reflexes.

These same considerations enter into the question of operating in extreme conditions, resulting from rapidly developing or neglected surgical conditions.

The sphygmomanometer, in conjunction with the pulse, is the quickest and surest means at our command with which to arrive at the proper decision, and the blood-pressure test has undoubtedly been the means of saving many lives under the conditions mentioned above.

When to Operate.—A fair or normal blood-pressure is always a good indication of the state of the vasomotor system, because vasodilatation invariably results in hypotension, and the degree of hypotension fairly indicates the severity of shock.

An extremely rapid pulse, associated either with a lowered blood-pressure or with one approximately normal, is an indication of a poor or shocked heart-muscle—one unlikely to withstand the strain of anesthesia.

The sphygmomanometer is often the means of determining the safe time to operate. Thus a dangerous condition of the cardiomotor and vasomotor mechanism will indicate appropriate restorative treatment, and will demonstrate plainly whether such measures are successful. The surgeon will thus be guided in his judgment as to the right time to operate.

The newer methods of anesthesia have done much to improve the character, method and technic of their administration. The chief effort of the anesthetist of today is to gain relaxation with a minimum amount

of the anesthetic, and to maintain anesthesia at any given level without fluctuations. Proper administration will produce a minimum of after sickness, prompt and thorough recovery from the anesthesia, a minimum of shock and an economic use of the anesthetic. All factors contributing to the future safety and welfare of the patient.

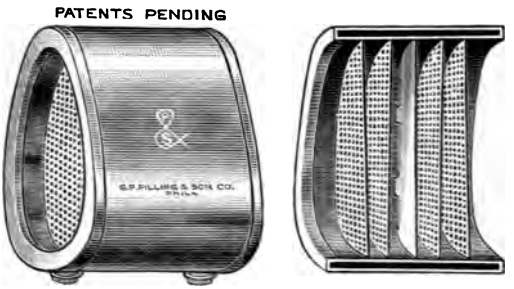


FIG. 20—Dr. Hill's Warm Vapor Ether Inhaler.

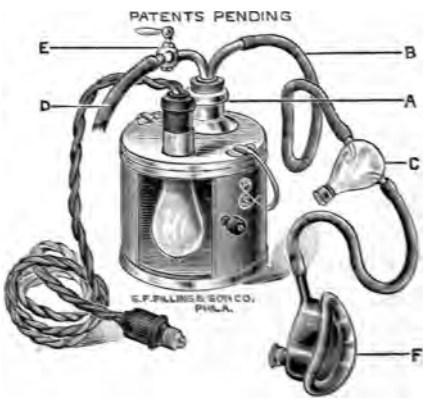


FIG. 21—Dr. Hill's Warm Vapor Ether-Oxygen Apparatus.

In no other way can the surgeon or anesthetist obtain the same satisfactory demonstration of normal anesthetization as by the continuous use of the sphygmomanometer.

It is not necessary to employ a large or expensive apparatus to obtain satisfactory results with warm ether vapor. The ether vaporizer and the ether and oxygen apparatus devised by R. Franklin Hill, M. D., of Philadelphia, shown in the accompanying cuts, very successfully administers a uniform percentage of warm ether vapor alone or in connection with oxygen.

The ether vaporizer is not much larger than the usual Allis cone. It has double walls, the spaces between which are filled with a paraffin oil, so that when placed in the sterilizer or hot water before using, it absorbs sufficient heat to vaporize and warm the ether passing through it.

The advantages of this apparatus are shortened time to produce anesthesia, almost complete elimination of the stage of excitement, breathing is more quiet and a smaller amount of ether is employed, both during anesthetization and in maintaining that condition. The tendency to post-operative nausea, vomiting and pneumonia is lessened greatly. The amount of ether is under complete control.

The ether and oxygen apparatus has recently met with approval by many surgeons. It can be employed to give ether alone or in connection with oxygen. Heat is obtained with a carbon electric lamp.

This apparatus is particularly useful for operations upon the head or face in which the cone inhaler cannot be used.

The face piece is detachable for sterilization.

Pulse and Pressure before Anesthesia.—The blood-pressure and pulse rate immediately preceding anesthesia is usually found above normal. This is due to the

excitement attending the approach of a radical procedure, and should be taken into consideration by the surgeon. This temporary disturbance in blood-pressure and pulse rate suggests the necessity of preliminary tests made, in quiet surroundings, the day before operation. This will establish the normal.

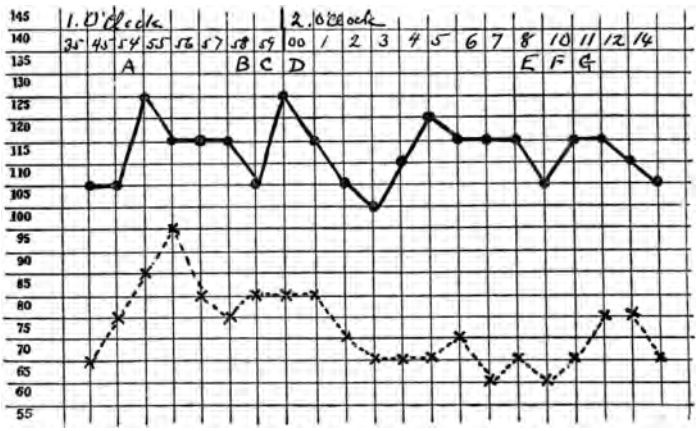


FIG. 22—Pulse and blood-pressure chart showing effect of nitrous-oxide and oxygen anesthesia. Anesthesia begun at A and ended at F.

Nitrous-Oxide.—During the first moments of administration of pure nitrous-oxide, the blood-pressure mounts rapidly upward, the rise equaling in some cases 50 or more mm. At the same time the pulse becomes very full and strong, while the rate may remain stationary or rise slightly. See Fig. 23. Immediately succeeding the anesthesia period, the pressure rapidly falls and the pulse rate rises. This effect of nitrous-oxide on blood-pressure will suggest caution in administering it to cases of arteriosclerosis or in any case where the patient's level is much above normal.

Nitrous-Oxide Combined with Oxygen.—The combined administration of nitrous-oxide and oxygen by one of the several apparatus now employed for this purpose is unattended by any of the alarming symptoms or rise in blood-pressure noted under nitrous-oxide alone.

This combination properly administered is capable of maintaining partial or profound anesthesia, for prolonged periods without materially affecting blood-pressure or pulse rate. The rise in pressure which accompanies the N_2O is either greatly reduced or entirely prevented by a proper percentage of oxygen. The accompanying chart is taken from Dr. Faught's collection and well shows the result of a proper administration of this combined anesthesia.

NOTES ON THE ADMINISTRATION OF ANESTHETICS BY DENTAL PRACTITIONERS.

The recent perfection and wide employment of anesthesia of all varieties by dental practitioners makes it imperative that its administrators should have not only a working knowledge of the methods of administration, but that they should also be familiar with at least the more important points of general pathology, particularly that which applies to the heart, the circulation and the kidneys, in order that they may be able to detect departures from normal, which might be magnified by the administration of any anesthetic, and so result in serious damage to the patient, if not in actual loss of life. Anyone attempting a prolonged administration of any anesthetic who has not this knowledge places both his patient's life and his own reputation in needless jeopardy.

In a recent discussion of this subject, Dr. Charles S. Tuttle, a dental anesthetist, formulated two pertinent questions which every administrator of dental anesthetics should be compelled to answer:

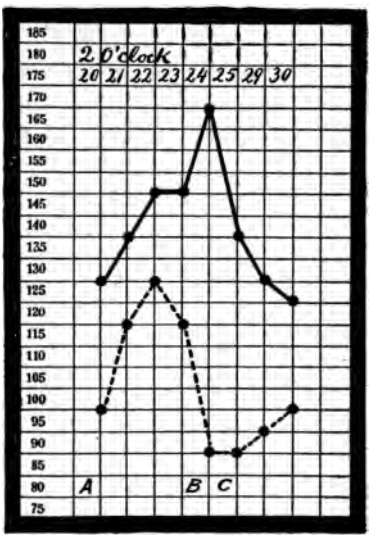


FIG. 23.—Administration of Pure Nitrous Oxide.

"To whom is it safe to administer an anesthetic?"

"What anesthetic should be selected to produce the best results with the least disturbance?"

He then cites the common but dangerous opinion of many dental surgeons who have for years employed nitrous-oxide: "If the patient is able to walk up the stairs to my office without prostration, I consider him fit."

Dr. Tuttle's reply to the first proposition is this:

"The safety in administering an anesthetic either by a physician or a dentist depends upon his possession of the requisite knowledge, his skill and his experience." Here he refers undoubtedly to the pos-

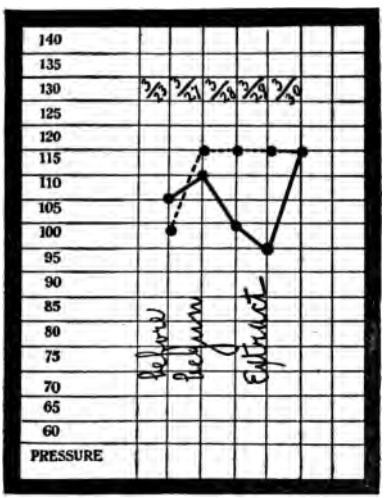


FIG. 24—Administration of Somnoform.

session of a knowledge, first of the physiology and pathology of the circulation; second, to adequate skill, not only in the direct administration of an anesthetic, but also to an ability to follow the course of the administration and to recognize the development of danger signals; and third, his experience, not only in the administration of an anesthetic by proper manipu-

lation of the apparatus, but also adequate experience in employing those means which are recognized as the proper aids to diagnosis as applied to the heart, circulation and kidneys.

In all their writings the more advanced dental anesthetists have laid stress upon the importance of the blood-pressure test, and possession of a working knowledge of the blood-pressure and its variations under dental anesthetics. We find that it is by means of the sphygmomanometer, which is the greatest single aid in the proper study of cases before, during and after the administration of anesthesia, and it has been proven that those who employ this study not only obtain better results in the average case, but are also better able to select their anesthetic, while the danger of the anesthetic is largely removed together with the elimination of those complications which so often follow a poorly administered anesthetic.

From the knowledge of the blood-pressure in the individual case requiring the anesthetic we are better able to judge, not only as a relative safety of the administration, but are also helped in the selection of the anesthesia, for it has been found that different anesthetics react upon the heart and circulation in different ways. It is now known that *nitrous oxide* alone produces a marked and rapid rise in blood-pressure (see Fig. 23), and that the administration of *oxygen* in conjunction with the nitrous oxide in proper percentage largely controls this rise (see Fig. 22). *Chloroform, ethyl chloride* and *somnoform* all have a direct tendency through their action upon the vasomotor system to cause a continued fall in blood-pressure throughout the length of their administra-

tion, while *ether* causes a prompt rise followed by a fall to above normal, which when properly administered is followed by but slight further variation, even

FIG. 25—Illustrating Application of Sphygmomanometer During Dental Anesthesia.

during administrations lasting several hours (see Fig. 22).

It will be seen at once that the danger of administration of nitrous oxide increases in proportion as the patient's pressure is above normal. That ether is probably the safest anesthetic which we have for prolonged operations, that chloroform, ethyl chloride and somnoform on account of their effect on blood-pressure may at any time suddenly become dangerous, even in the normal case where the original pressure is found to be normal (see Fig. 26) and that probably, in high pressure cases, these may be safer than other anesthetics because of their tendency to cause a fall rather than a rise during anesthesia.

Following the lead of the more advanced surgeons, it is recommended that dentists should regularly employ the blood-pressure test, and that an effort should be made to obtain the normal level before the administration of the anesthetic, which will serve as a guide later. During the anesthesia period blood-pressure observations should be made continually at intervals of one, two or three minutes, depending on the nature and duration of the case, and that the blood-pressure should be watched for several hours after the administration whenever chloroform, somnoform or ethyl chloride is used for any length of time.

Method of Testing.—It is only necessary to consider the systolic pressure, an observation which can be taken by anyone, even an untrained assistant, after a few lessons. Intelligent patients have learned to appreciate the necessity of these observations and are very willing to submit to them. It is unnecessary

here to go into any detail in regard to the physiology and pathology of the circulation or of anesthesia from the surgical standpoint, as these points are all fully explained in the following pages.

Finally the observations of Gibson and others upon the relation of blood-pressure and pulse are significant and have a direct bearing from the dental standpoint. It has been found in normal conditions that the blood-pressure in mm. Hg. remains ordinarily above the pulse-rate in beats per minute, and that change in the relation of these figures is a sign or danger which should call for appropriate measure to re-establish the normal relation, whether this is the withdrawal of the anesthetic, an increase in the amount of oxygen or the employment of active restorative measure.

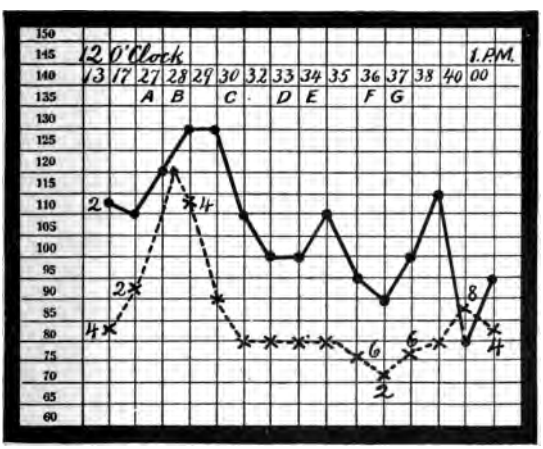


FIG. 26—Taken from a case which shows graphically the working of Gibson's rule.

USUAL EFFECT OF DIFFERENT ANESTHETICS ON BLOOD-PRESSURE.

Ether alone causes a moderate rise in blood-pressure during the early period of its administration. Struggling causes a further rise, together with an acceleration in pulse rate. These changes rapidly subside as the stage of anesthesia is reached, so that, under ordinary circumstances, the pulse and blood-pressure remain at or about the same levels on the chart as were noted prior to the removal of the case to the operating room.

Dangerous symptoms occurring during the course of operation will usually early be shown by changes in pulse rate and blood-pressure; the blood-pressure falling and the pulse rate rising, so that this change developing during anesthesia will indicate to the surgeon the advisability of haste in completing the operation or the necessity of dividing the operation into two stages.

Chloroform is a dangerous anesthetic under all circumstances and its use should always be attended with great care. It has been demonstrated that blood-pressure falls gradually from the very beginning of the administration. This fall may occur during the first few minutes and be so great as to endanger life. When this anesthetic is used, the blood-pressure test should be continuously employed, and every effort made to avoid a dangerous fall in blood-pressure.

Ethyl Chloride.—This drug, according to the last report of the anesthesia commission of A. M. A., is a safe anesthetic, and observations on blood-pressure seem to bear this out. There is a tendency to a

falling pressure which, however, is not great, and which is easily controlled by the admission of sufficient air.

Spinal Anesthesia.—According to Colcord, in surgical anesthesia there is a rise at first, due in part to mental excitement, puncture, drawing off of fluid and to the injection of the solution. This lasts from 15 to 20 minutes; then the pressure falls to near the normal line and the chart shows remarkably few excursions above or below during the operation. According to Cushing, if the anesthesia extends too high into the dorsal cord, paralysis of the efferent nerves to the splanchnic area may be induced, causing a dangerous fall in blood-pressure.

Local Anesthesia.—In local anesthesia several factors influence blood-pressure. These are:

1. Cocaine itself produces a rise in blood-pressure.
2. The mental excitement, always a variable factor, may produce a rise.
3. Any pain from injury to nerves, not anesthetized, will cause a rise.
4. Injury to nerves completely anesthetized will cause no change in blood-pressure.

Operative Effect on Blood-pressure.—The surgeon should be in possession of the facts concerning the influence of operative procedures on blood-pressure. Thus, when the skin is incised, there is usually an abrupt fall in blood-pressure, transitory in nature. The same lowering is noted when the peritoneum is incised and also when viscera are pulled upon or exposed to the drying influence of air. Two procedures, therefore, to be studiously avoided, or, if necessary, care-

ful watch should be made for the occurrence of shock, with the sphygmomanometer, during such procedures.

Cataract Operation.—No careful surgeon ever attempts to enter an eye either in cases of glaucoma or cataract without first carefully studying the blood-pressure. The indications in the presence of a high blood-pressure are first to reduce the pressure and then operate. This method will save a large percentage of eyes which were formerly lost by intraocular hemorrhage, a complication the direct result of a sudden reduction of tension in an eye, having diseased blood-vessels, which were unable to withstand the sudden loss of support following the scleral incision.

CHAPTER VIII.

THERAPEUTICS INDICATED BY BLOOD-PRESSURE CHANGES

Pilling-Faught Pocket Sphygmomanometer in Use.

CHAPTER VIII

THERAPEUTICS

The study of blood-pressure frequently furnishes the key to proper treatment in a number of diseases; it also furnishes a reliable guide as to the efficiency of the measures employed, as well as the time during which treatment should be continued.

It is not within the scope of this little work to more than touch upon a few of the most important points in the relation of blood-pressure to the management of disease.

Hypotension.—The general symptoms accompanying diminished blood-pressure indicate in no uncertain manner the necessity of tonic treatment. In cases of emergency, with suddenly falling pressure and evidence of collapse, adrenalin intravenously or hypodermically is indicated.

For the sudden drop in blood-pressure occurring in advanced arteriosclerosis, digitalis is indicated, provided there is no evidence of marked myocardial degeneration, in which event strychnin is the safer drug to use.

In lowered blood-pressure from hemorrhage or profuse and prolonged diarrhea, the pressure is the best indicator of the amount and the frequency for the use of saline infusion or the Murphy treatment.

Hypertension.—High pressure in the apoplectically inclined calls for active and continued pressure-reducing treatment. Among the drugs which are gener-

ally depended upon to accomplish this change are the nitrites, of which a freshly prepared solution of sodium nitrite will be found the most serviceable, being easy of administration and prolonged in action.

In the treatment of **aortic aneurysm** with high pressure, the use of blood-pressure reducing agents may materially prolong life by reducing the tendency to rupture, and at the same time afford relief from the most distressing symptom—pain—by lessening the tension in the aneurysmal sac, thereby relieving the nerve irritation and the pressure upon surrounding organs or tissues.

In **acute Bright's**, after failing to reduce the pressure by the usual measures, it may sometimes be controlled by the electric-light sweat bath. In one case a reduction of from 20 to 40 millimeters was obtained, the beneficial effects lasting for many hours, so that regular observation of the pressure determined the proper interval between the sweats.

Albuminuria.—Albumen appears in the urine whenever the kidneys are passively congested, and its importance, when due to this cause, is often greatly exaggerated. Albuminuria, associated with kidney disease, is nearly always accompanied with elevation in blood-pressure; albumen, when due to other causes, is not usually so accompanied. As these two causes of albuminuria demand almost diametrically opposite treatment, their differentiation is of the utmost importance.

When to Treat High Blood-pressure.—It is important to realize that the mere finding of an elevated blood-pressure is not always an indication that it should be reduced; it is always a bad rule to promiscuously institute measures to reduce pressure. This should

never be done. Blood-pressure reduction should only be attempted for a good reason, based upon a careful study of the case. Long continued high pressure often becomes an essential to the well-being of the individual, which, if interfered with, may so destroy the circulatory equilibrium that disaster results. The chief group of drugs employed to control and lower high blood-pressure are vasodilators. These act chiefly upon the sympathetic and vasomotor systems, cause a widening of the blood channels and a consequent lowering of the blood-pressure. The value of the sphygmomanometer is chiefly in demonstrating the efficiency of the measures employed in any given case. This guards the practitioner from placing too much confidence in any particular remedy, because he can readily ascertain whether he is accomplishing the desired result. This is particularly important because numerous investigators have shown that no particular drug can be depended upon to produce the same results under all conditions, even with a maximum dose. Another important function of the sphygmomanometer in therapeutics is to determine the period of duration and action of the particular drug employed, thereby enabling the physician to intelligently manage his therapeutic measures and accomplish his purpose. The sphygmomanometer has also shown that many measures other than drugs may be relied upon to control and lower high blood-pressure, often more advantageously. Thus, in the employment of vapor baths of various sorts, we can control the effect and determine the proper time for another treatment.

In venesection the amount of blood which may safely be withdrawn is best determined by noting the effect of the bleeding on blood-pressure

THERAPEUTIC EFFECT OF OSTEOPATHIC TREATMENT ON BLOOD-PRESSURE.

J. P. Downing, A. B., D. O., has made a series of studies with the sphygmomanometer over a period of three years and has records of 300 cases. From the result of this study it is apparent that the measures employed were productive of good results in certain classes of high tension cases.

This seems to be particularly true of those in which there is no physical reason for the hypertension (many of the cases were studied by regular practitioners in order to exclude organic conditions before the treatment was applied). Here spinal treatment has a decided tendency to reduce the systolic pressure, the effects of which are usually lasting, often persisting for 24 hours or more. It is not uncommon to get a fall of from 15 to 40 mm. after a treatment occupying 15 or 20 minutes. These results are confirmed by Abrams and others, who are at the present time employing methods somewhat similar to those of osteopathy, and in which the lower cervical region is the point of therapeutic attack.

It is evident also that the measures applied by osteopathy are productive of good results when applied to raising an abnormally low pressure. In 16 cases of anemia reported, the pressure ranged from 80 to 100, which, after 2½ months' treatment, with one exception, all came up and remained above 110.

In 6 cases of chlorosis, in which the blood-pressure averaged 90 before treatment, four were raised to 120 and remained up, one came to 110, and only one failed to respond to treatment.

CHAPTER IX.

BLOOD-PRESSURE IN LIFE INSURANCE

LIFE INSURANCE

The medical director of one of the largest insurance companies speaking of the Faught Pocket Sphygmomanometer writes: "As you know we have used the Faught Sphygmomanometer for some months, and it is entirely satisfactory; it is certainly most convenient.

CHAPTER IX

BLOOD-PRESSURE IN LIFE INSURANCE

During the past several years a majority of life insurance companies have admitted the value of the blood-pressure test as a prognostic aid in life insurance examinations. At the present time most of the larger companies require the test of every applicant for life insurance. A larger number require the test of all applicants over forty years, in overweights and underweights, and in all those in whom the character of the risk has been previously questioned by any company.

The chief value of this test lies in the fact that, by a study of these records in conjunction with that of the pulse, we are able to detect beginning pathologic change in the cardio-vascular system or kidneys, often before there are any definite signs in the physical examination, personal history or urine. Another good reason for the universal employment of the blood-pressure test in life insurance examinations is the fact that the apparent character of the pulse and of the vessel walls does not always convey the correct information regarding the condition of the applicant. Clinicians have agreed that the estimation of blood-pressure by palpation is not satisfactory and that even the most experienced occasionally fall into grave error.

Normal or Permissible Variation.—Unlike the temperature, which has a fixed normal, the blood-pressure in

the normal individual is a variable factor. This is because of the complicated cardiomotor and vasomotor mechanisms. These are under sympathetic control, and are therefore affected by the varying conditions to which the body is subjected during every 24 hours. These variations result from changes in posture, exercise, excitement and from digestive activity. They are also dependent upon the time of day, age, sex and the physical development of the individual. Fortunately the amount of alteration in pressure caused by these varying conditions is not great, and we are therefore able to lay down a fairly definite rule which has for its object the determination of the permissible variation in pressure in any individual of a given age.

Formula to Estimate Normal Pressure.—The writer devised and published, in 1910, a formula which may be used to estimate the normal systolic blood-pressure, which gives results conforming closely with the figures obtained from careful clinical reports. The formula is as follows: "Consider the normal average systolic blood-pressure in men at age of 20 to be 120 mm. Then add 1 mm. for every additional 2 years of life." Thus a man aged 30 should have a normal average systolic blood-pressure of 125 mm., while a man aged 60 should average 140 mm. The difference in pressure between men and women is approximately 10 mm., being lower in women.

Clinical evidence shows that the ordinary daily variations in pressure in any individual rarely amount to more than 36 mm. If we accept this, then a variation of 17, either above or below the normal average, may be allowed.

Application of Test.—As a routine measure the left arm should be employed and the cuff should be applied to the bare arm. The applicant should be in a comfortable position, preferably sitting. Time should be allowed to permit the circulation to become quieted, and nervous individuals should be assured of the harmlessness of the test.

A single reading equal to or just above the estimated maximum pressure for a given individual should never be accepted as final, as this pressure may be accidental and may never again be met. Observations should be repeated at a later time or upon a different day before reporting the pressure.

A moderate degree of **arteriosclerosis** may cause an elevation in pressure but slightly above the estimated high normal; 15 or 20 mm. above this calls for further investigation, not only of the blood-pressure, but of the general physical condition of the applicant.

The blood-pressure will frequently read between 160 and 180 mm. in the average case of uncomplicated arteriosclerosis.

Nephritis.—Urinalysis does not always demonstrate chronic nephritis, particularly in individuals of apparent normal health. On the other hand, it is said that the blood-pressure in an established case of chronic interstitial nephritis is rarely below 200 mm. In acute nephritis the blood-pressure, while above the normal, may not be that high. The finding of a high blood-pressure with a normal urine calls for repeated urinalysis.

Metabolic Albuminuria.—The finding of a trace of albumen and a few hyaline casts in the urine, with a normal blood-pressure, suggests the probability that

the urinary condition is not the result of kidney alteration, but is metabolic in character. Such a condition can readily be relieved by appropriate treatment while the case is held under advisement, and many of them will eventually obtain the amount of insurance desired.

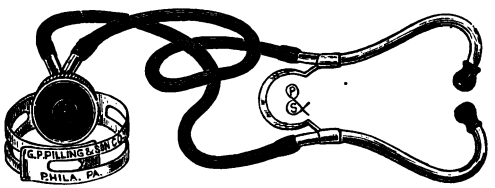
Overweights.—This group shows an unfavorable mortality in life insurance statistics, particularly of the older ages. Given an individual of modern overweight, where the physical examination and history are favorable, the final decision is often made upon the result of the blood-pressure test; accepting them when the pressure is normal and declining them when the pressure reaches or passes the normal high limit.

Chronic Myocarditis.—This is the most difficult condition to diagnose, especially by the insurance examiner, because these cases often require long study and careful observation in order to arrive at the proper rating. A history of hard physical labor, excessive brain work, alcoholism or syphilis is often significant. In the early cases the systolic pressure is not always altered, so that recourse must be had to the functional tests of Graupner and Shapiro (see page 74), and also to the estimation of the diastolic and pulse pressures.

Incipient Tuberculosis.—Slight reduction in blood-pressure, combined with modern elevation in pulse rate, even without fever, suggests the possibility of an active pulmonary lesion. If this be combined with fever and a history of slight loss in weight, the case should be declined on this presumptive evidence. In tuberculosis the blood-pressure is usually low and the pulse pressure diminished.

PILLING-STAMP BRACELET STETHOSCOPE

IMPORTANCE OF ACCURACY IN BLOOD-PRESSURE EXAMINATIONS.



Of all methods of recording systolic and diastolic readings there is not one dissenting opinion among scientists that the auscultatory is the one absolutely correct method. Until the development of the Stamp Bracelet Stethoscope the labor and difficulty surrounding accurate auscultatory observations in blood-pressure were almost insurmountable because of lack of properly adjusted and sufficiently delicate apparatus.

THE METHODS OF TAKING READINGS.

There are probably only four recognized methods of making readings and they are:

1. Visible.
2. Palpatory.
3. Auscultatory.
4. Diastolic Indicators.

Of these the most accurate for both systolic and diastolic readings is the auscultatory method. Prob-

ably there is a slight difference between diastolics with this method and the other three, but in spite of this, it is the most satisfactory in every way.

It is, of course, for purposes of comparison, always important to use the same method in a series of observations, whether on individuals or groups.

Accurate records of the blood-pressure with any sphygmomanometer can be obtained only by means of the auscultatory method. By this method it is only necessary to distinguish between the presence and absence of certain plainly audible sounds, which are not affected to any extent by varying conditions, such as size of arm, exact location of vessel, or the personal equation of the examiner.

All large Insurance Companies now recognize not only the importance of a systolic, but also of a diastolic determination.

Ofttimes we find that a relatively high systolic is only nature's effort to compensate and that there is no danger from it whatever.

This observation can be determined only by the accurate readings made possible by using the Stamp Bracelet.

NORMAL RELATION OF SYSTOLIC TO DIASTOLIC PRESSURE.

There exists a relationship between the systolic and diastolic pressures and their resultant pulse pressure that has been generally accepted as follows: Where 120-80-40 may represent the systolic, diastolic and pulse pressure, respectively, we might also have 200-135-65 as the systolic, diastolic and pulse pressure, respectively, and still, other things being equal, have

perfect compensation, relation and a normal balance between the various parts of the cardio-vascular system.

Before this accurate method of diastolic determination was devised, moderately elevated pressures, which had had only the systolic determination, would not even have been considered by the Insurance Companies, or if under observation by a physician, the systolic reading alone would have been misleading.

Dr. Faught, in his work on "Blood-Pressure," says: "The determination of the pulse pressure is of the greatest importance in the study of diseased conditions, particularly in the estimate of cardiac muscular efficiency and in determining the prognosis of certain valvular and blood-vessel diseases and toxemic states."

Dr. J. W. Fisher, Medical Director of the Northwestern Mutual Life Insurance Company, in an article, "The Diagnostic Value of the Use of the Sphygmomanometer in Examinations for Life Insurance," says:

"No practitioner of medicine should be without a sphygmomanometer. He has in this instrument a most valuable aid in diagnosis."

Dr. Haven Emerson, in "Archives of Internal Medicine," says: "The danger of accepting applicants who are not really entitled to insurance is greatly lessened by the determination of the *pulse pressure,* and no insurance company desires to refuse a policy to a good risk, and in no way can this be *positively ascertained* except by the use of the sphygmomanometer."

Another observer says: The diastolic readings are more important than the systolic. He further states that the auscultatory method of obtaining the diastolic pressure is now well recognized as the only accurate

and simple method, because if you observe the dial of an aneroid, the needle is showing wide excursions, making it impossible to determine the correct reading, as you do not know what point in the excursion of the needle to note.

The fluctuations of the mercurial column offer the same difficulty.

By observing the changes in pulse pressure of our cases under treatment, we obtain the most accurate idea possible of the results that are being obtained; far more so than when we utilize the systolic pressure alone.

Now, accepting the evidence in favor of the importance of accurate diastolic determinations and the claim that the auscultatory method is the only accurate one, we pass to the choice of methods.

Some physicians have been in the habit of tucking the stethoscope under the cuff. It is obviously impossible by this method to avoid crepitus and annoyance and interference with the sounds and to obtain a correct reading, for the instant you release the air by the various methods used with all forms of sphygmomanometers the cuff must yield or slip over the stethoscope, with a resulting crepitus. Manifestly, to hold the stethoscope in place manually is both difficult and inaccurate.

The Stamp Bracelet Stethoscope may be used with all forms of sphygmomanometer such as the Faught Standard, Faught Pocket, Cardiac, Tycos, Janeway, Stanton, Riva Rocci, etc.

In employing this instrument, attach the arm-band of the sphygmomanometer to the arm above the elbow in the usual way, then the Bracelet is quickly and simply adjusted over the radial artery just below the

bifurcation. The especially designed arterial button fits snugly over the artery; the sounds are read quickly with unfailing scientific accuracy.

Precision is now assured; personal errors on the part of the observer are eliminated and remarkably ready and general acceptance by the profession at large of the

Pilling-Stamp Bracelet Stethoscope

is proof enough of its high degree of efficiency in giving to the practitioner and the examiner alike an absolutely accurate method of making determinations and getting satisfactory interpretations in blood-pressure.

16
REASONS
Why The Pilling-Faught
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1. There is no mechanical detail of practical value in any sphygmomanometer which is not embodied in those of the Faught-Pilling make. In this apparatus you will find:

2. A scale running to 300 mm. Hg.

3. The scale graduated in millimeters requires no computation to determine the actual pressure.

4. An adjustable dial which allows for changes in temperature and atmospheric pressure.

5. The scale plainly marked in black and red on a white background—easy to read.

6. The aneroid mechanism has four chambers, assuring absolute smoothness in operation. The same advantage as a "six" auto over the old one or two cylinder.

7. The metal pump of convenient size is positively guarded by an air-tight valve.

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9. The arm-band is standard width (5 inches) and of sufficient length to meet all requirements.

10. The pressure bag measures 9x5 inches.

11. The outer fabric of the arm-band is of washable material and permits easy sterilization.

12. Arrangement for quick removal of the pressure bag from the outer covering for cleaning and other purposes.

13. An attractive leather case which holds the gauge, arm-band and pump, and is of convenient size to fit in the pocket.

14. Permanent accuracy which has been demonstrated by thousands of satisfied users working under all conditions during a number of years.

15. The Faught Apparatus is in general use by thousands of physicians, by the U. S. Government, many life insurance companies and research laboratories, as the standard of accuracy.

16. Not a spring instrument.

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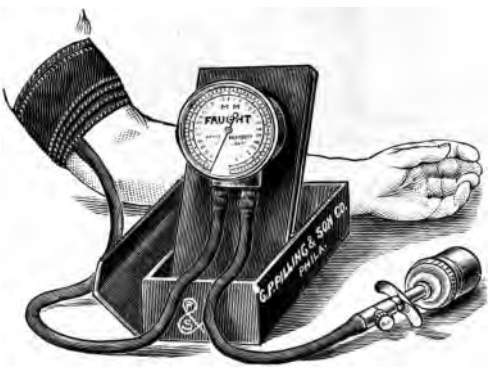

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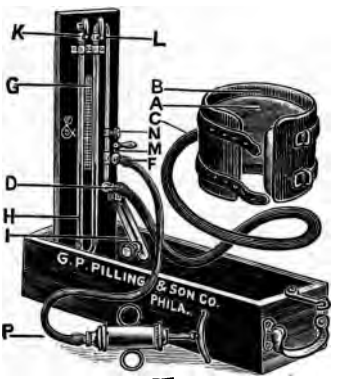

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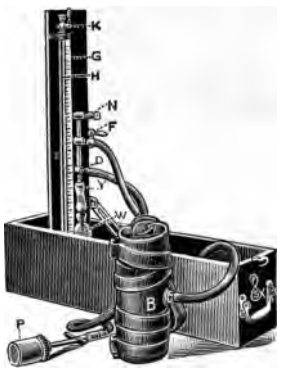

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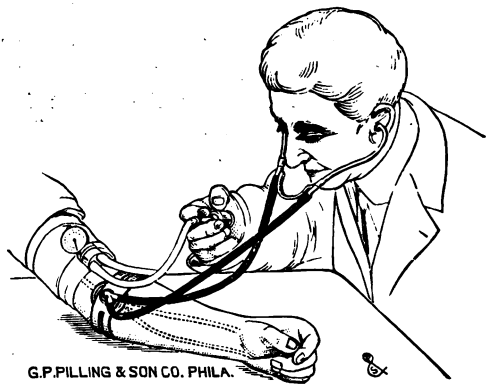

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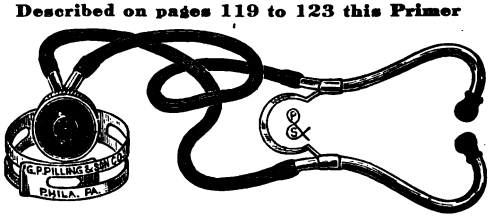
AUSCULTATORY BLOOD PRESSURE

Described on pages 119 to 123 this Primer



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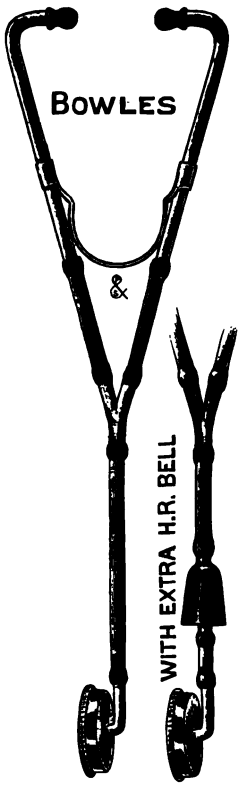

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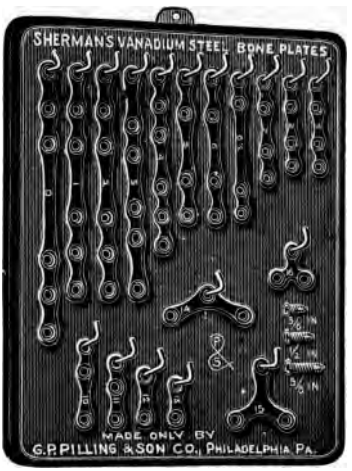

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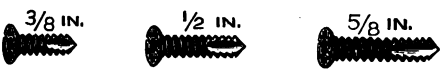

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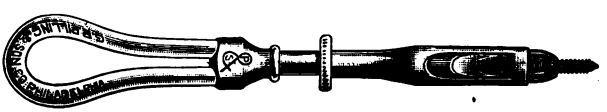

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